SCIENCE ABSTRACTS.

Section A.—PHYSICS.

DECEMBER 1908.

GENERAL PHYSICS.

1893. *An Electric Hygroscope.* **J. Pionchon.** (Comptes Rendus, 146. pp. 809–810, April 13, 1908.)—The hygroscope is based upon the property of a clean glass surface of attracting moisture in proportion to the moisture of the atmosphere in contact with it. A glass tube 10 cm. long, closed at one end, is silvered inside and out to within 1 cm. of the open end. The bottom is then cut off, leaving a fresh cut which separates the two silver surfaces. This cut is the sensitive portion of the instrument. The cut is, however, not left in the rough state, nor fused, but is polished with fine emery. Wires are connected with the inner and outer coatings, and are inserted in a circuit containing a galvanometer and a battery of 100 volts. The deflection of the galvanometer is then found to vary greatly with the moisture of the atmosphere. The mere approach of a moist body affects it. The hand held at a distance of 1 cm. produces various effects in accordance with the part which happens to be near the sensitive surface. The point of the finger throws the spot right off the scale. The amount of moisture liberated by the heat of the hand from a paper tube is easily detected. The zero of the instrument is constant, and is rapidly recovered. E. E. F.

1894. *Ball Hardness-testing Machine.* **A. Martens** and **E. Heyn.** (Zeitschr. Vereines Deutsch. Ing. 52. pp. 1719–1723, Oct. 24, 1908. Communication from the Kgl. Materialprüfungsamt, Grosslichterfelde.)—The machine consists of a small press of the hydraulic diaphragm type [see Abstract No. 867 (1908)], together with an arrangement for indicating the depth of impression made by the ball. Three rods resting on the surface of the test-piece pass freely through holes in the ball holder and cross-head of the press, bearing against a piston. Thus the relative movement of test-piece and ball holder causes mercury to be forced from the cylinder in which the piston fits, and up a glass tube. The movement thus indicated is the sum of the depth of impression and the elastic deformation of test-piece and apparatus. Upon removal of pressure, the ball just being in contact at the bottom of impression, the height of the mercury column indicates the actual depth of impression. Other methods of interpreting the readings of this indicator are mentioned. It is found that for various metals the pressure P is in each case proportional to the depth of impression h up to $h = 0{\cdot}05$ mm. In most cases the curve begins to deviate slightly beyond this point, P increasing more rapidly than h. Hence it is proposed that the value of P in kg. for $h = 0{\cdot}05$ mm. be adopted as a measure of hardness in the Brinell test, using a ball of 5 mm. diam. In the case of Sn, Mg, and an antifriction alloy, the metal continued to flow for such a long time under the load, if higher than the limit mentioned, that the accuracy of the results was vitiated. Results obtained with various metals and alloys are given. It is found that the rate of cooling of such alloys as antifriction metal and bearing brass affects the hardness considerably; *e.g.*, the hardness of a sand casting of bearing brass was only 61 per cent. of that of a chill casting of the same alloy. Meyer [see Abstract No. 1868 (1908)] shows that the relation between load and diam. of impression is not a simple one—a result which accords with the choice of depth of impression rather than its diam. as a measure of the hardness. F. R.

1895. *Microstructure of Portland Cement.* **E. Stern.** (Kgl. Materialprüfungsamt, Mitt. 26. 6. 1908. Stahl u. Eisen, 28. pp. 1542–1546, Oct. 21, 1908. Abstract.)—The normal microstructure of a Portland cement is two constituents, one of which is alite. It has been found impossible as yet to say with certainty from its microstructure the age of a cement (*i.e.*, the period which has elapsed since wetting), but the proportion of the second constituent gradually increases at the expense of the alite, and it is expected that sufficient evidence will shortly be forthcoming to establish that the crystalline change which constitutes hardening proceeds in the minute spaces between the untransformed grains of cement. The presence of as little as 1 or 2 per cent. of slag in cement can be recognised microscopically; roughly quantitative estimations of prepared samples were fairly successful. The specimen is etched with 25 per cent. hydrofluoric acid for the determination of presence of slag. Photomicrographs are given, some taken by transmitted light, but for the greater part specimens were prepared by metallographic methods. The specimens polish in relief upon cloth. Results with various etching reagents are given. An alcoholic solution of HCl is useful for normal cement. F. R.

1896. *Strength of Columns.* **W. E. Lilly.** (Engineering, 86. pp. 670–672, Nov. 13, 1908. Paper read before the British Assoc. at Dublin.)—Curves are given showing the relation, for a large number of ½-in. diam. round-ended solid columns of cast and mild steels, wrought and cast irons, between buckling load and ratio of length to radius of gyration, l/ρ. The values are in close agreement with published results of large-scale experiments. Differently from other writers, the author holds that although the load which produces failure agrees closely with values calculated by Euler's formula, the deflection under load is considerable, and therefore it is better to admit that the load producing failure will bend the column to its proof deflection. For values of l/ρ greater than 120 very little difference can be observed between the results for round rods and for rods of other sections, but between 120 and 80 the circular column gives slightly better results than columns of other sections. The manner of derivation of the Rankine-Gordon formula is open to criticism in that it assumes the deflection of a column to be the same as that of the column loaded as a beam, whereas it is actually less under similar conditions. Further, the value of C cannot be constant if the max. stress be constant. The author derives a formula in which these errors are avoided, viz. :—

$$\frac{P}{A}=\frac{f}{1+\frac{fl^2}{\pi^2E\rho^2}\left(\frac{1}{1+\frac{\pi^2E\rho^2}{fl^2}}\right)}.$$

Upon application of this formula, however, the Rankine-Gordon formula is preferred for use, as the effect of its error as compared with the derived formula is merely to make a slightly greater allowance for bending stress, *i.e.*, an error on the side of safety. The values deduced from the experiments for the constants of the Rankine-Gordon formula, $P/A=f/(1+fl^2/\pi^2E\rho^2)$, are given in the following table, values of C for fixed-ended columns being taken as 1/4 of the values for round-ended columns.

	f.	E.	*c* for Round-ended Columns.	*c* for Fixed-ended Columns.
Cast tool steel	150,000	88,000,000	1/2200	1/8800
Bessemer steel	110,000	81,000,000	1/2800	1/11200
Bright rolled mild steel	80,000	80,000,000	1/4000	1/16000
Ditto annealed	60,000	80,000,000	1/5000	1/20000
Wrought iron	55,000	26,000,000	1/4500	1/18000
Cast iron.....................	110,000	14,000,000	1/1300	1/5200

F. R.

1897. *Films and Small Drops.* **G. Bakker.** (Ann. d. Physik, 26. 1. pp. 35–58, May 12, 1908.)—It is not legitimate to assume the existence of "capillary layers" whose thickness is half the thickness of a "black film." At a given temperature a capillary layer in contact with its vapour is always the same thing. If, therefore, a capillary layer is stable when it forms a large fluid mass, every other capillary layer must be unstable. The smallest thickness of a liquid film is always greater than twice the thickness of a capillary layer. The liquid between them must always be as thick as the radius of attraction, and since this is about equal to the thickness of the capillary layer, a film must always be three times the thickness of a capillary layer. According to the author's calculations [see Abstracts Nos. 2106 (1904) and 1188 (1906)], the thickness of a plane capillary layer of ether at — 89·3° C. is 8·6 $\mu\mu$, and of water at 46° C., 2·4 $\mu\mu$. According to Johonnott [Abstract No. 1338 (1899)], the thickness of black soap-films is at least 6 $\mu\mu$, which is nearly three times the above value for water. As regards small drops, the author concludes similarly that when at a certain temperature a spherical droplet has its smallest size, the thickness of its spherical capillary shell is of the same order of magnitude as the capillary layer. E. E. F.

1898. *The Ether.* **O. Lodge.** (Chem. News, 97. pp. 255–258, May 29, and pp. 269–270, June 5, 1908. Abstract of Discourse delivered at Royal Institution, Feb. 21, 1908.)—The oldest valid and conclusive requisition of an ethereal medium depends on the incapacity of matter to transmit luminous vibrations. The ether is more than a nominative case to the verb "to undulate." It is the bearer of gravitational and electromagnetic stress, and probably primordial substratum of matter. The phenomena of kinetic stability show that a fluid may simulate the properties of a solid. A charge suddenly set in motion in a magnetic field shows a tendency to deflection at right angles to the impulse, as does a spinning-top. This suggests an ether spinning about the line joining the charge and the magnetic pole. The three vectors at right angles to each other, called current, magnetism, and motion respectively, represent a fundamental relation between ether and matter, and constitute the link between electricity, magnetism, and mechanics. Inertia can be explained electromagnetically provided the ethereal density is granted as of the order of 10^{12} gm. per cm.^{3}. The elasticity of the ether would then have to be of the order of 10^{33} c.g.s.; and if this is due to intrinsic turbulence, the speed of the whirling or rotational elasticity must be of the same order as the velocity of light. The ethereal tension near the earth's surface, required to explain gravity by its rate of variation, is of the order 6×10^{11} c.g.s. units. The tension near the sun is 2,500 times as great. With different spheres in general, it is proportional to the density and to the superficial area. Near a bullet 1 in. in diam. it is of the order 10^{-6}; and near an atom or electron about 10^{-21}. In order to set up a tension equal to the critical, or presumably disruptive, stress in the ether (10^{33} c.g.s.), a globe of the density of the earth would have to have a radius of eight light-years. That the density of the ether is not infinite is indicated by the finite velocity of light. [See Abstracts Nos. 958, 959 (1907).] E. E. F.

1899. *Applications of Bessel's Functions to Physics.* **F. Purser.** (Roy. Irish Acad., Proc. 26. Section A. pp. 25–66, Sept., 1906.)—The author first obtains two solutions of the equation—

$$\frac{\partial^2 u}{\partial^2 x} + \frac{1}{x}\frac{\partial u}{\partial x} = u.$$

In a previous paper (May, 1902) the solution $K_0(x)$ is given. It is now proved that $\gamma_0(x)$, which is given by—

$$Y_0(x) = K_0(x) \,.\, \log x + \epsilon K_0(x) + \phi(x)$$

is also a solution, where ϵ is a numerical constant and—

$$\phi(x) = -x^2/4 - 3x^4/128 - 11x^6/36 \times 384 - \ldots,$$

which is a convergent series. When x is great, semi-converging series are obtained for $K_0(x)$ and $Y_0(x)$ which are extremely convenient for computation. He applies this solution to solve problems in (1) heat conduction; (2) statical electricity; (3) gravitational potential; (4) elasticity; and (5) hydrodynamics. Some of the problems discussed are new, and in some cases exact solutions are obtained. In the case of the approximate solutions given, the author's method enables the degree of accuracy of the solution to be readily estimated, which is a notable step in advance. A. R.

1900. *The Isonephs and Cloudiness and Latitude Belts.* **A. Woeikow [Voeikov].** (Meteorolog. Zeitschr. 25. pp. 357–360, Aug., 1908.)—In his "Bases de la Météorologie Dynamique" Teisserenc de Bort states that the nebulosity is maximum on the equator, feeble between latitude 15° and 35° N. and S., greater between 35° and 50°, and that the sky is clearer again in higher latitudes especially in winter. Bort, the author points out, overlooks in his characteristics two factors—local cooling by radiation, leading to banks of mist, especially in mean European latitudes and in Alpine valleys, and the mists on partly ice-covered seas. The statement does not agree with Bort's own charts nor with the facts, as the author shows in detail. There is now much more material available for a study of this problem. The author would distinguish the two hemispheres. In the northern hemisphere the cloud maximum reaches up to latitude 10°, and further N. in summer; there is little cloudiness in the regions of trade winds and deserts, latitude 20° to 35°; more cloudiness further N., maximum in winter between latitude 60° and 70°, in summer in the highest latitudes reached; beyond 70° the cloudiness diminishes again during the winter. In the southern hemisphere a general equatorial maximum does not occur; the cloudiness diminishes between 15° and 20°, attains its minimum between 20° and 30°; it then increases up to latitude 60° in winter and to 70° in summer to decrease again finally. The Antarctic Continent is assumed to have its northern border near latitude 70°.

H. B.

1901. *The Air Temperature during Snowfalls in and near Berlin.* **C. Kassner.** (Meteorolog. Zeitschr. 25. pp. 348–357, Aug., 1908.)—The author reviews the scanty literature on the subject and examines the data collected at Berlin (Agricultural Hochschule and Teltower-str.) and at Blankenburg, near Berlin, during the years 1896 to 1905. Snowfalls are more common with temperatures above freezing-point, chiefly between 0 and + 1° C., than with temperatures below 0°; snowflakes have been seen at temperatures of + 7° or 8° C. (at Breslau and Husum even at + 16°) and of — 18° C.; but only 1·5 per cent. of all snowfalls occur at temperatures below — 8° C. It snows at higher temperatures in town than in the country, or rather the town temperature is, as a rule, higher than the country temperature. Soft granular snow (Graupeln) occurs rarely at temperatures below 0°, and is most common in April. Snowfalls do not lower the temperature, except with strong, gusty wind. Observations made at the aeronautical stations of Tegel and Lindenberg show that the temperature fall may be 1° C. in 170,200,500 m. when snow or ice needles are noticed. Ice needles fell on Dec. 4, 1902, when the temperature was — 11° below and — 16° at 1,767 m. Snow clouds are, according to Assmann and Berson, met chiefly at temperatures between 0 and — 10° C.; their average height is 2,650 m. at — 5·6° C. Berson passed through snow clouds at — 43·7° and — 46·8° C. at altitudes of 8,730 and 9,010 m. Clouds of ice needles were found chiefly between — 10° and — 20° C., averages — 14° C. and 3,620 m., at about the same temperatures and heights as snow clouds. H. B.

1902. *Daily Variation of the Wind Force at the High-level Stations of Southern India.* **J. Hann.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 555–618, May, 1908. Meteorolog. Zeitschr. 25. pp. 220–222, May, 1908. Abstract.)—The author has calculated the diurnal course of the wind force from four- and six-years' records obtained at Dodabetta Peak (2,633 m.) and Kodaikánal Observatory (2,343 m.) [see Abstract No. 750 (1908)]. The north-east monsoon, blowing from Oct. to May, has its maximum of wind force at about 10 a.m. and its minimum at 5 p.m.; as soon as the south-west monsoon sets in in June the maximum goes back to midnight or the early morning hours, and the minimum to noon. In order to trace this peculiar change, the author submits the daily and hourly curves for the wind, air pressure, and temperature to harmonic analysis, and finds the explanation in the double diurnal variations of the barometer which affect easterly and westerly winds in different ways. H. B.

1903. *Intensity and Chemical Action of Tropical Sunlight.* **G. J. Fowler.** (Manchester Lit. and Phil. Soc., Mem. 52. 14. pp. 1–20, Aug. 12, 1908.)—Making use as an actinometer of the reaction involving the liberation of iodine from an acid solution of KI by light, the author gives tables of results obtained by exposure to full sunlight in various parts of the world. The number of mgm. of iodine liberated per 100 c.cm. of solution varies per hour from 16 to 30 in Calcutta (March–April) to 18 up to 42 in the Arabian Sea (May). For Manchester the range is 1 (Dec.) to 14 (June). Thus the Arabian Sea in one day receives as much actinic sunlight as would reach Manchester in six weeks of continuous wintry sunshine. From the scattered observations it is concluded that the photo-chemical effects of tropical sunlight do not differ in kind from those observed under European conditions. L. H. W.

1904. *Method of determining the Centre of a Cyclone.* **T. Okada.** (Mathematico-Physical Soc., Tōkyō, Proc. 4. 16. pp. 326–329, May, 1908.)—It is usual to locate the centre of a cyclone from the form of isobars on weather charts. In Japan, however, most of the cyclones pass over the surrounding seas and ocean, and so their centres cannot be determined in this way. The author gives a geometrical method of finding the centre of the cyclone when the isobars are only partially known. Following Helmholtz, a cyclone is considered as a "spiral" vortex in which the stream lines are equiangular spirals with poles on the axis. The angle between the wind and the barometric gradient is therefore constant. The resultant velocity is also inversely proportional to the distance from the axis, and the fall of pressure at any point within the vortex below that at the outskirts of it is inversely proportional to the square of the distance from the axis. In obtaining the last result the effect of the deflecting force due to the earth's rotation has been neglected. This is admissible in tropical cyclones, since the effect of this force is very small compared with the centrifugal force of the rotatory motion of the air in low latitudes. Let us suppose that A, B, and C are the positions of three stations which lie in the cyclonic region. Let AA′, BB′, and CC′ be the directions of the wind at these stations, and let P and Q be the points of intersection of AA′ and BB′ and BB′ and CC′ respectively. If O be the centre of the cyclone the angle OAA′ equals the angle OBB; A, P, B, and O therefore lie on the same circle. Similarly B, Q, C, and O lie on a circle. The required point O is therefore one of the points of intersection of the two circles. Again, if v_1, v_2, and v_3 be the wind velocities at the three stations and r_1, r_2, and r_3 the distances of the stations from O, we have $v_1/v_2 = r_2/r_1$ and $v_2/v_3 = r_3/r_2$. Hence O lies on the locus of the point whose distances from A and B are in the inverse ratio of the velocities of the wind at these points. This obviously gives another construction for finding O. If p be the barometric pressure on the outskirts of the cyclone and p_1, p_2, and p_3 the pressures at the three stations we have $\sqrt{p-p_2}/\sqrt{p-p_1} = r_1/r_2$, &c., and thus we get a third construction for O. The construction may be of use for locating the centres of typhoons which travel along the Pacific coast of Japan or over the seas near the Riukiu Islands. The geometrical methods are applied to finding the centre of the Tsukushi typhoon of July 24, 1895. The results are in satisfactory accordance. A. R.

1905. *Geology and Radio-active Substances.* **G. F. Becker.** (Geolog. Soc. of America, Bull. 19. pp. 113–146. Abstract by A. L. Day in Science, 28. pp. 526–527, Oct. 16, 1908.)—A review of the physical data on radio-active substances is given with a discussion of their bearing on terrestrial and astronomical questions. Assuming that the relation now established between helium, radium, and uranium points to the common origin of the chemical elements, attention is called to the fact that only helium, hydrogen and nebulium have been identified in the nebulæ, and that an ordinary progression can be noticed in the atomic weight of the identifiable elements found in the stars. The spectroscope has never indicated the presence of uranium in any celestial body, in the sun or in meteoric matter, although helium is widely distributed. The question of the earth's age, and a theory of the formation of granite which undertakes to account for the enormous energy content of the radio-active group of minerals also form part of the subject-matter of the paper. G. E. A.

1906. *Inequalities in the Epoch of Sun-spot Variation.* **H. H. Turner.** (Roy. Astronom. Soc., Monthly Notices, 68. pp. 656–662, 1908. Papers of the I.U.S.R.-Computing Bureau, No. 8.)—Sun-spot maxima and minima occur on the average at intervals of 11·125 years. The individual epochs show discordances which have been tabulated for 26 years by Wolfer. Analysing these by means of Schuster's periodogram, the author finds evidence of two periodicities, in one of which the phase advances 58° per period of 11⅛ years, in the other the phase advances only 20°, the cycles being thus completed in about 75 and 200 years respectively. C. P. B.

1907. *Solar Constant.* **J. Scheiner.** (Roy. Astronom. Soc., Monthly Notices, 68. pp. 662–663, 1908.)—Summary of results of observations during June and July, 1908, with an Ångström electric compensation pyrheliometer, on the top of the Gorner Grat in Switzerland. The solar constant is determined as 2·22 to 2·29 gm.-calories, with a probable error of 2 per cent. Working from this, the average temperature of the sun is calculated to be about 7,065°. C. P. B.

1908. *Solar Rotation from Dark Calcium Flocculi.* **P. Fox.** (Astrophys. Journ. 28. pp. 117–120, Sept., 1908.)—Accumulated evidence from various workers supports the assumption that dark calcium flocculi are prominences seen in projection on the sun's disc. Their coincidence with the dark hydrogen flocculi is further evidence of their being high-level phenomena, and this suggested the feasibility of determining the solar rotation by their systematic observation. Tables are given showing the movements of four dark flocculi, care being taken not to measure any feature far removed from the central meridian, as that would introduce a parallax error of unknown amount. The resulting velocities indicate that the motion of this layer agrees more closely with the motion of the hydrogen flocculi than with the hydrogen of the reversing layer, although the values are even closer to those of H_2 calcium. C. P. B.

1909. *Orbital Elements of Algol.* **R. H. Curtiss.** (Astrophys. Journ. 28. pp. 150–161, Sept., 1908.)—For some time it has been recognised that the interval between successive light-minima of *Algol* varies minutely and regularly, but the first co-ordinations of the variations were only determined in 1888, when Chandler showed them to be closely represented by an empirical periodic expression involving three sine terms with periods of 130, 35, and 16 years. Various theories have been advanced to account for these terms, chiefly by Chandler, Bauschinger, and Tisserand. The present paper gives the results of recent radial-velocity determinations and their influence on the probable cause of the variation. It appears probable that the orbit of the centre of mass of the eclipsing pair is nearly, if not quite, circular, and that at least three masses are involved in the system, two of which are extremely close, while the third is at a distance comparable with the earth's distance from the sun, unless the mass of the third body is relatively small. Periodic variations of the times of light-minima should occur to the extent of about 10 minutes, with a period of about 1·9 years. It is hoped that these variations may be detected by means of photometric determinations. C. P. B.

1910. *Wave-length of H_δ and H_ϵ in Solar Spectrum.* **J. Evershed.** (Astrophys. Journ. 28. pp. 162–168, Sept., 1908.)—The wave-length of the blue hydrogen line H_δ, given by Rowland as 4102·000, has at various times been called in question from the fact that it does not agree with laboratory determinations from vacuum tube spectra [Abstract No. 1862 (1899)]. Arrangements were made to photograph the line in the spectrum of the chromosphere, measures being made on both east and west limbs of the sun to avoid radial velocity due to rotation. A powerful spectrograph was employed, consisting of a 3½-in. collimator with focal length of 36 in. (914 mm.), a plane diffraction grating having 14,428 lines to the inch, and a camera of 7-ft. (213 cm.) focal length. This was used in connection with the 12-in. Cooke photo-visual objective of the Kodaikánal Observatory, giving a solar image about 60 mm. diam. The best results were obtained in the fourth order, giving a scale of dispersion of 1 mm. = 1·9 Å. For H_δ the value 4101·900 was obtained, and for H_ϵ, $\lambda = 3970{\cdot}212$. C. P. B.

1911. *Grey Tropical Spot on Jupiter.* **J. C. Solá.** (Comptes Rendus, 147. pp. 583–585, Oct. 5, 1908.)—This peculiar feature is situated in the Jovian latitude of the great red spot, but has a more rapid rotation by about 20 sec. In 1902 the author observed a conjunction of the two spots, and was able to note that the grey spot passed *between* the red spot and the planet; the observation was subsequently confirmed during a later conjunction in 1904. Again in 1907 the grey spot was seen hidden by the red one, and there was an appearance suggesting a disturbance such as might be produced by friction of the two bodies. These appearances seem to demonstrate the existence of several superposed currents in the atmosphere of Jupiter. C. P. B.

1912. *Solar Vortices and Magnetic Fields.* **E. P. Lewis.** (Nature, 78. pp. 569–570, Oct. 8, 1908.)—With respect to the interpretation of the doubling of lines observed by Hale in sun-spot spectra [Abstract No. 1586 (1908)], the present writer thinks it is not probable that the effects could be accounted for by unequal diffusivity of the positive and negative ions, or by centrifugal separation, nor does he think it necessary to assume, with Zeeman, that the magnetic effects are due to electrons participating in the vortical motion. We know that all luminous vapours giving a line spectrum, and therefore capable of showing the Zeeman-effect, are positively charged—for instance, a sodium or lithium vapour flame between two condenser plates is attracted by the negative plate, this fact being used by Lenard to determine the velocity of the positive ions. Riecke and Stark have shown that if a sodium or lithium salt is placed on the kathode of a long spark the coloured vapour remains in the neighbourhood; if on the anode it is projected across the length of the gap [Abstract No. 3250 (1904)]. Hemsalech proved that the metallic vapour is projected solely from the positive electrode, and Stark has shown that part of the luminous vapour in a mercury arc giving a band spectrum is unaffected by a magnetic field, while the part giving a line spectrum is positively charged [Abstract No. 2888 (1904)]. What becomes of the negative ions is not yet clear. Whether the vapours taking part in the sun-spot vortices are positively charged may be determined from Hale's observations on the Zeeman-effect. It would be interesting to know if the solar vortices follow a definite cyclonic law, as in the case in the earth's atmosphere. If so, a definite polarity should be produced by the aggregate of sun-spots, and accompanying magnetic fluctuations on the earth should be always in one direction, while if the vortices are accidental the terrestrial disturbances should be irregular. The writer points out that it might be worth while to consider the effects upon the perturbations of the earth and moon of the force moments due to non-coincidence of the polar and magnetic axes. C. P. B.

1913. *New Dark Ring of Planet Saturn.* (Kiel Circular, No. 104. Nature, 78. p. 612, Oct. 15, 1908. Abstract.)—The observers at the Geneva Observatory report the discovery of a new dusky ring surrounding the bright rings of Saturn. **Schaer.** (Astronom. Nachr., No. 4277. p. 81, Oct. 20, 1908. Nature, 78. p. 678, Oct. 29, 1908. Abstract.)—On Oct. 8, 1908, the white ring was bordered by two narrow bands of a brownish hue, both bands being seen beyond the planet's edge when the seeing conditions were good. Other observers have specially looked for the phenomenon, and report they see nothing abnormal. C. P. B.

1914. *Changes in and Spectrum of Comet* 1908c (*Morehouse*). **W. H. M. Christie.** (Nature, 78. p. 539, Oct. 1, 1908.)—Long-exposure photographs of the comet were obtained at Greenwich Observatory with the 30-in. reflector on Sept. 6, 7, 8, 14, 17, 18, 21, 25 and 26, the exposures ranging from 45 min. to 1 hour. The comet showed a bright tail to a distance of 1¼° from the nucleus; the tail structure varied greatly from night to night, and to trace these changes more clearly arrangements were made to take a series of pictures at short intervals every available evening. **G. Bigourdan.** (Comptes Rendus, 147. p. 579, Oct. 5, 1908.)—Observations show considerable evidence of rapid change in the brilliancy and structure of all parts of the comet, notably in the extent and direction of the tail streamers. **A. de la Baume Pluvinel** and **F. Baldet.** (Comptes Rendus, 147. pp. 666–669, Oct. 19, 1908.)—By employing a prismatic camera of very short focal length several photographs of the spectrum of the comet have been obtained at Juvisey, near Paris. Notable differences have been found from the spectra of Comet Daniel, photographed in 1907 with the same apparatus. While Comet Daniel showed considerable continuous spectrum extending from the red to ultraviolet, the recent Comet Morehouse showed little or none. Moreover, in the latter the bands of hydrocarbon are practically absent, the chief bands of the spectrum being due to cyanogen. Notable also is the spectrum being well defined far into the tail, in some cases as much as 34 min. of arc from the nucleus. Additional observations with a 60°-prism in place of the one of 20° 18′ first employed revealed the fact that all the spectrum lines were double, thus confirming the results obtained by Chrétien on Comet Daniel. The spectrograms were obtained on Oct. 4, 5, and 7, with exposures of about 2¼ hours. **L. Rabourdin.** (Comptes Rendus, 147. pp. 731–732, Oct. 26, 1908.)—Description of a series of photographs taken on the evenings of Oct. 14, 16, 17, 20, 22, and 28, 1908, with the telescope of 1 m. aperture at

Meudon. Good images were obtained with exposures as short as 5 min., using Lumière rapid plates. The pictures show a strong nucleus with a forked principal tail and very long aigrettes in variable numbers. The central nucleus appears surrounded by several envelopes. Very rapid changes occurred, often noticeable in a single hour. **H. Deslandres and A. Bernard.** (Comptes Rendus, 147. pp. 774–777, Nov. 2, 1908.)—Photographs of the comet's spectrum, taken with a short-focus prismatic camera, show the chief lines to be due to cyanogen and some unknown substance. Many of the lines are double. **J. Guillaume.** (Comptes Rendus, 147. pp. 883–884, Nov. 9, 1908.)—Details of observations of the changes in form of the comet during Sept. and Oct., 1908. C. P. B.

1915. *Spectrum of Comet Daniel, 1907d.* **W. W. Campbell.** (Astrophys. Journ. 28. pp. 229–236, Oct., 1908.)—Good spectrograms of the comet were photographed during Aug., 1907, at the Lick Observatory, using a slit spectrograph. In all 61 bright lines are recorded, ranging from λ3867 to λ5634, and these are compared with Kayser and Runge's arc spectra of carbon and cyanogen. It is evident, from an examination of these tables, that there can be no doubt that the second, third, fourth, and fifth bands of the arc spectrum of carbon, and the second and third bands of cyanogen, are represented in the comet. No trace of hydrogen bright lines could be seen. C. P. B.

1916. *Parallax and Proper Motions of Double Star, Krueger 60.* **E. E. Barnard.** (Roy. Astronom. Soc., Monthly Notices, 68. pp. 629–655, 1908.)—After reviewing the observational history of this remarkable star, the details relating to the investigation of its parallax from visual micrometer measures with the 40-in. Yerkes telescope are given. The resulting value is $\pi = +0.249'' \pm 0.0105''$, indicating that the star is distant about 830,000 times the sun's distance. To traverse this distance light would require 13·1 years. C. P. B.

1917. *Effect of Star Colours on Astronomical Refraction-Constant.* **S. Hirayama.** (Mathematico-Physical Soc., Tōkyō, Proc. 4. 17. pp. 340–344, June, 1908. Nature, 78. p. 612, Oct. 15, 1908. Abstract.)—The observations of Courvoisier, Bauschinger, and Nyrén were reduced by dividing their stars into three groups, according to colour, and then deriving the corrections to the assumed value of the constant corresponding to the several colours. The results show that (1) the colour effect is not shown in any single series ; (2) the arithmetical mean of the three series is 60·19″ for whitish-yellow stars, 60·16″ for yellow stars, and 60·12″ for reddish-yellow stars. C. P. B.

REFERENCES.

1918. *Variation of Latitude and Earth Tremors.* **de Montessus de Ballore.** (Comptes Rendus, 147. pp. 655–656, Oct. 12, 1908.)—The epochs of great seismic upheaval have been noticed to occur with some apparent relation to the period of latitude variation, and it has been suggested that the two phenomena may be related as cause and effect. When critically examined, however, it is seen that the small disturbances evidenced by latitude variation are far smaller than the actual dislocations measured in the case of large earthquakes, and the author concludes that the coincidence is fortuitous. C. P. B.

1919. *Violle-Savélief Actinometer.* **D. Smirnow.** (Meteorolog. Zeitschr. 25. pp. 299–312, July, 1908.)—The author discusses the use of the modified form due to Savélief of Violle's actinometer, and shows that it is suitable for measuring the sun's radiation, &c. As regards simplicity of working, portability, and constancy it is better than the Chwolson actinometer and also Ångström's compensation-pyrheliometer. The various corrections to be applied to the readings of the instrument are dealt with. A. W.

1920. *New Method for Calibrating Capillary Tubes.* **B. v. Szyszkowski.** (Zeitschr. Phys. Chem. 64. 2. pp. 201–214, Sept. 4, 1908.)—This method is based on measurements of the heights to which a liquid rises in various parts of the capillary. Detailed measurements for two tubes are given, the liquids employed being water and dilute solutions of *iso*butyric acid. For details of the method the original must be consulted. T. H. P.

1921. *Motion of Capillary Boundary Layers.* **R. H. Weber.** (Ann. d. Physik 26. 5. pp. 884–898, Aug. 25, 1908.)—A mathematical treatment.

1922. *Physical Relations affecting Matter in Diverse Stages of Subdivision.* **S. T. Preston.** (Phil. Mag. 16. pp. 345–351, Aug., 1908.)

1923. *Gravitational Action of Saturn's Ring.* **P. Stroobant.** (Comptes Rendus, 147. pp. 664–666, Oct. 19, 1908.)—Taking the ring to be a surface of revolution produced by the rotation, around the polar axis of the planet, of a plane curve symmetrical to the equatorial plane, the gravitational action of the ring is analytically determined, and this will be employed for investigating the mass of the ring from observations of the satellites. C. P. B.

1924. *Anomalous Refraction and Solar Phenomena.* **W. H. Julius.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 213–222, Oct. 28, 1908.)—The author proposes to explain all solar phenomena, as revealed by recent results with the spectroheliograph, by ascribing them to anomalous refraction among the different layers of the sun's vaporous atmosphere. Tests were made on sunlight passed through sodium vapour, using the 5-ft. spectroheliograph at Mount Wilson. C. P. B.

1925. *Movement of Comet Wolf.* **M. Kamenskij.** (Acad. Sci. St. Pétersbourg, Bull. 13. pp. 1041–1066, Oct. 1, 1908.)—An analytical investigation of the movement of the comet, presented in form of tables of the eccentric anomaly. C. P. B.

1926. *Orbit of 42 Coma Berenices.* **Doberck.** (Astronom. Nachr., No. 4276. p. 55, 1908. Nature, 78. p. 644, Oct. 22, 1908. Abstract.)—New elements of the orbit. The system is of special interest in that the apparent motion is in a straight line, the plane of the orbit lying in the line of sight. The period is 25·335 years; the eccentricity 0·4965; apparent length of semi-major axis 0·674″. C. P. B.

1927. *Star Colours and Spectra.* **W. S. Franks.** (Roy. Astronom. Soc., Monthly Notices, 68. pp. 672–675, 1908.)—In a former paper [Abstract No. 214 (1908)] the author has given the result of an investigation into the relation between the colours and spectra of 1,360 bright stars, in both hemispheres. A new comparison has been made consequent on the publication of the *Revised Harvard Photometry*, and 3,497 stars are included, reaching down to 6½ magnitude. The tabulations are arranged for seven grades of colour, and show that the sequence of colours corresponds closely with the sequence of spectral class. C. P. B.

1928. *Orbits of Spectroscopic Binaries.* **H. C. Plummer.** (Astrophys. Journ. 28. pp. 212–222, Oct., 1908.)—Notes on the methods of determining binary orbits from the velocity curve given by measurement of spectrograms. C. P. B.

LIGHT.

1929. *A One-exposure Three-colour Camera.* **W. de W. Abney.** (Photographic Journ. 48. pp. 331–338, Oct., 1908.)—This camera, described at the British Association Dublin meeting, has a lens consisting of three narrow strips placed side by side: the rays through the two outer strips are deflected outwards by mirrors at 45° and restored to their original direction by mirrors, again at 45°. Three images are thus formed on the plate, and these are adjusted to the same size by supplementary lenses. Also, the distances of the second principal points of the combinations are made equal to one another, so that the sizes of image and foci of the combinations remain equal to one another for near objects. With this camera there is a minimum of stereoscopic effect. Steel mirrors are used, and the angle of view is 36°.
A. D.

1930. *Pressure of Light on Moving Surfaces.* **R. v. Hirsch.** (Phys. Zeitschr. 9. pp. 495–498, Aug. 1, 1908.)—The pressure of light on moving mirrors is deduced from the pressure upon stationary mirrors and the second law of thermodynamics. The temperature in the reflected beam is simply proportional to the frequency. If light falls upon a moving mirror it is reflected with a different frequency and temperature. The light-pressure at the same time performs work, so that the second law is applicable. The result for the pressure is $p = (2S/c)[(1+\beta)/(1-\beta)]$, where S is the energy vertically incident per unit time upon unit surface moving towards the source with a velocity βc, c being the velocity of light. The author also calculates the pressure upon a moving refracting surface, both with the aid of Lorentz's equations and of Hertz's equations, and finds that the pressure on the refracting surface is equal to the pressure of the reflected portion. The optical drag ("Mitführungs-koefficient") is calculated from the light-pressure according to ordinary mechanical principles. It appears that Fizeau's experiment is quite in accord with Hertz's theory.
E. E. F.

1931. *Dispersion.* **H. Bremekamp.** (Archives Néerlandaises, 13. Nos. 3 and 4. pp. 316–341, 1908.)—The author here discusses various questions which present themselves in the electromagnetic theory of the dispersion of light. The paper starts with the following assumptions: (1) Each molecule contains an even number of electrons. (2) These electrons are present in pairs, the two of any one pair having charges which are equal and opposite. (3) The positive electrons are bound to fixed points of the molecule, the negative are free to move in all directions about their position of equilibrium, from which, however, their range is very limited. They are under the action of a force directed to this position and proportional to the displacement, and have, further, a resistance proportional to the velocity. (4) The different electrons of a molecule move independently of each other. Under the influence of the forces named, they can execute simple vibrations having different periods for the different electrons. The author thus finds a dispersion formula which may be written in the familiar form—

$$n^2 = b^2 + \frac{M_1}{\lambda^2 - \lambda_1^2} + \frac{M_2}{\lambda^2 - \lambda_2^2}.$$

On comparing this with experimental results, including the dispersion in sodium vapour, it is found, although right in the main, to be somewhat at fault, especially as regards the signification of the constant. The hypotheses are then modified, a molecule being thenceforth regarded as a single system whose degrees of freedom are at least equal in number to the lines in the spectrum of the substance. A new dispersion formula is thus obtained, which can be put in the same form as the first, but in the two the coefficients have slightly different meanings. The paper concludes with a discussion on Drude's theory. E. H. B.

1932. *Selective Absorption.* **K. Kilchling** and **J. Koenigsberger.** (Deutsch. Phys. Gesell., Verh. 10. 14. pp. 537–541, July 30, 1908. Physikal. Inst., Freiburg.)—Increase of temperature always produces a displacement of the absorption band of a solid towards the red. The band becomes broader at the same time. The displacement is greater the more the maximum lies towards the violet. Yellow, red, and brown bodies are therefore more subject to a temperature change of absorption than green or blue bodies. These facts are easily explained on the electron theory of dispersion. At higher temperatures the distance between the electron and the positive nucleus about which it revolves becomes larger. Its period of revolution becomes longer, and since it absorbs the waves of its own period, the absorption band shifts towards the greater wave-lengths. It also becomes broader owing to increased damping by molecular collisions. In extreme cold, as J. Becquerel has shown, absorption bands of crystals become very sharp. When the temperature exceeds a certain point the electrons are liberated: the substance becomes a conductor, and therefore opaque. These can be observed in crystals of molybdenum sulphide. The more such electronic conductivity such a body possesses the greater is its paramagnetism. E. E. F.

1933. *Transparent Metallic Films.* **T. Turner.** (Roy. Soc., Proc. Ser. A. 81. pp. 301–310, Nov. 9, 1908.)—The green colour transmitted by gold-leaf fades and white light is transmitted when the gold is heated on glass in air or hydrogen to 550° C. Microscopic examination shows that the gold is actually opaque and has aggregated, leaving clear spaces. Silver-leaf becomes transparent progressively when heated in an oxidising atmosphere between 240° and 400°. It is concluded that an oxide is formed and again decomposed, silver being deposited in an amorphous form, transparent in moderate thicknesses. A slight volatilisation is noticeable in a current of air at about 700°. When copper-leaf is heated in an oxidising atmosphere it becomes successively, with higher temperatures, emerald green, light olive, dark olive, and a dark port-wine colour in transmitted light. The nature of the change in this case appears to be mainly the production of oxide films, but the leaf becomes transparent when the oxidation is as yet only superficial. Aluminium and Dutch metal do not become transparent upon heating, and the action of H_2S upon metals has not as yet been found to give transparent products. The theory is advanced that as copper, and presumably iron, yield transparent bodies during their oxidation, surface films are produced upon heating them which are capable of giving the colours of the spectrum, *i.e.*, the temper colours of iron, and the oxidation tints of copper. F. R.

1934. *Refraction and Dispersion of Helium.* **K. Herrmann.** (Deutsch. Phys. Gesell., Verh. 10. 13. pp. 476–482, July 15, 1908.)—The dispersion of

helium was determined by means of the bright rays of mercury [see Abstract No. 1255 (1908)]. The author has since added the red cadmium line 643·8, for which he finds the refractive index of helium to be 0·00003406. The eighth decimal is the only place that is doubtful, and the author regards the dispersion of helium as proved. The relative dispersion is the difference between the refractive indices of the F and C lines divided by that of the D line minus 1. The reciprocals of these relative dispersions are 98·0 for air, 65·9 for hydrogen, and 89·9 for helium. [See also Abstract No. 1079 (1908).]
E. E. F.

1935. *Explanation of Halos.* **G. Zappa.** (Accad. Lincei, Atti, 17. pp. 519–531, April 26, 1908.)—The theory of halos propounded by Brandes and Pernter reduces it to reflection by ice crystals. This theory requires a systematic study of minimum deviation and internal reflection in crystals. Such an investigation is here furnished. For the sake of simplicity sections in one plane only are dealt with. One of the rules obtained is that the minimum deviation is equal to double the angle of incidence *plus* or *minus* the angle between the side of entrance and the side of exit, accordingly as to whether the two rays, incident or emergent, meet outside or inside the quadrilateral formed by the two sides and their normals. The case of only two reflections is the most important as regards white halos. That case is therefore dealt with in greater detail. E. E. F.

1936. *Measurement of Extinction Angles.* **F. E. Wright.** (Amer. Journ. Sci. 26. pp. 349–390, Oct., 1908.)—The optical properties made use of in the practical determination of minerals under the microscope are refractive index, birefringence, optic axial angle, optical character, extinction angles, colour, and pleochroism. For a mineral plate in thin section the extinction angle is the angle between a known crystallographic direction and one of the optic ellipsoidal axes, and the problem of its measurement is discussed theoretically, and the equations covering the different methods applied to extinction-angle measurements derived. The methods are grouped into two classes, those of general application and those of limited applicability. The first class is again subdivided; either the crystal is revolved between crossed nicols about its position of true extinction, or the crystal remains stationary and the accuracy of its position of true extinction tested by revolving the upper nicol or by inserting one of the several different optical devices to increase the sensitiveness of the test under the prescribed conditions of illumination. These devices are described, and include the Calderon ocular, the Bertrand ocular, the Bravais-Stöber plate, the Traube plate, twinned plates and wedges of selenite, artificially twinned plates and wedges of quartz, the circularly polarising bi-quartz wedge plate, and the bi-nicol ocular. The last two are the most universal, and can be so used that the phenomena observed are the most sensitive possible to attain by devices of this type. The relative sensitiveness of the different methods is then compared. G. E. A.

1937. *Lummer's Double Rings.* **H. Schulz.** (Ann. d. Physik, 26. 1. pp. 139–166, May 12, 1908. Extract from Dissertation, Breslau, 1908.)—The ellipticity of reflected light in Brewster's angle increases with increasing refractive index of the reflecting surface. The boundary between positive and negative ellipticity of the reflected light is found at a refractive index of about 1·46. The point of duplication which appears in Lummer's rings in polarised light is essentially dependent upon the situation of the plane of polarisation of the first brush. Hence the rotation of the plane of polarisation and the ratio of Fresnel's coefficients for light vibrating normally or parallel to the plane of incidence may be determined. Ellipticity due to reflection is discovered by the decrease of the maximum difference of brightness produced during a complete turn of the analyser. If that is measured photometrically, the ellipticity may be determined. Positive and negative ellipticity change the position of the point of duplication in opposite ways. The position of this point depends upon that of the axis or the binormal of the crystal with respect to the plane of polarisation of the first pencil of light. Hence Lummer's double rings offer a means of investigating double refraction by their reflection. E. E. F.

1938. *Photographic Half-tone Screens.* **H. Calmels and L. P. Clerc.** (Comptes Rendus, 146. pp. 965–967, May 11, 1908.)—Calculates the successive "isophotes" or curves of equal illumination for various degrees of illumination of the centre of the patch produced by each aperture in the screen. These curves are traced out on a diagram. In the centre of the patch they are circles. But if the lines are at right angles to each other, and the diaphragm is a square whose diagonals are parallel to the lines, the circles tend to become squares with more or less hyperbolic corners. E. E. F.

1939. *Rotation of Tourmaline by Plane-polarised Light.* **J. A. Anderson.** (Nature, 78. p. 418, Sept. 3, 1908. Phys. Zeitschr. 9. p. 707, Oct. 25, 1908.)—When a beam of plane-polarised light is incident normally on a plate of tourmaline cut parallel to the optic axis, it will be absorbed or transmitted according to the relation of the axis of the tourmaline to the plane of polarisation of the incident light. If the arrangement is such that the light is absorbed, then in a given time a definite amount of heat energy will have passed from the source of light into the plate of tourmaline, and if, as is necessarily true, the former is at a high temperature, while the latter is at a low one, it is plain that the entropy of the system will have been increased. The same increase of entropy would not have taken place if the orientation of the tourmaline had been such that the light had been transmitted. Since the entropy of a system always tends to increase, it seemed to the author of some interest to try what would happen if a plate of tourmaline were suspended so as to be free to rotate about an axis perpendicular to its faces and then a beam of plane-polarised light were allowed to fall on it in the direction of the axis of rotation, the arrangement being such that the plane of polarisation should make an angle of 45° with the optic axis of the tourmaline. A preliminary experiment was made in July, 1908, and rotations observed, parts of the effects being ascribed, however, to the radiometer action and the pressure of light. It appeared, however, that an outstanding part was due to the action under consideration. A more careful investigation is to be made shortly. E. H. B.

1940. *Elliptic Polarisation of Transmitted Light.* **L. Natanson.** (Acad. Sci. Cracovie, Bull. No. 8. pp. 764–783, Oct., 1908.)—Fresnel's manner of accounting for the rotation of a transmitted beam does not cover the case in which a medium has two different refractive indices for opposite circular vibrations. The emergent vibration will be elliptical, because the corresponding coefficients of extinction will also be different. Such effects have been observed by Cotton (1896). The author discusses the matter by means of Drude's electromagnetic version of the theory of Boussinesq. He shows that on the whole the evidence is not in favour of the simplest form of theory, which assumes only one class of vibrating electrons; and to carry out the process of verification with strictness, on the assumption of a poly-electronic formula, would require knowledge which is not likely to be soon available. But it is clear that if, within an absorption band of a photogyric substance, the rotation of the plane of polarisation and the ellipticity produced by the medium are determined, we are able to calculate for the substance in question the intensity of the damping agency which is known to be always present in electro-molecular vibrations. E. E. F.

1941. *Ionic Theories of Magneto-optic Rotation.* **F. E. Hackett.** (Roy. Irish Acad., Proc. 26. Section A. pp. 1–24, July, 1906.)—There are two competing ionic theories of magneto-optic rotation, the chief criterion to decide between them being as follows: The hypothesis which assigns the effect to rotating ions indicates that the magnetic rotation should *change sign* when crossing an absorption band, while the second formula, based on the Hall-effect, leads to the conclusion that the rotation should be of the *same sign* on each side of an absorption band. The latter condition is satisfied completely in the case of sodium vapour as investigated by Wood. The two theories are here tested by comparison with various experimental results, and the author infers that the rotation observed has the magnitude which would arise from the influence of the Hall-effect on the motion of the electrons. It is accordingly concluded that the theory based on the Hall-effect supplies a satisfactory explanation of the phenomenon of magneto-optic rotation, and that it must be accepted in preference to the theory of rotating ions, which only accounts for a negligible part of the rotation, unless impossible values are assigned to the radii of the ionic orbits. E. H. B.

1942. *Discontinuous Spectra of the Kathodic Luminescence of various Organic Compounds.* **O. Fischer.** (Zeitschr. wiss. Phot. 6. pp. 305–326, Sept., 1908.)—The author has repeated the examination of the spectra obtained from solid aromatic compounds exposed to the action of kathode rays [compare Goldstein, Abstracts Nos. 1644 and 1928 (1904)], and has, in addition, photographed the spectra and measured accurately the wave-lengths of the various bands. The compounds examined were: *p*- and *o*-xylenes, naphthalene, β-naphthonitrile, α- and β-acetnaphthalides, α- and β-naphthols, α- and β-naphthylamines, diphenyl, dibenzyl, phenanthrene, anthracene, dibromoanthracene, and xanthone. In all cases the bands have sharp edges at the ends corresponding with the short waves, and fuzzy ones at the other ends. With the xylenes and naphthalene there appear to be three series of bands in each spectrum. A number of the compounds exhibited the emission of short-waved light rays, which produced in the spectrum three wide bands, apparently always in the same positions; these substances hence probably have a common molecular constituent. T. H. P.

1943. *Residual Rays in the Long-wave Spectrum.* **E. F. Nichols** and **W. S. Day.** (Phys. Rev. 27. pp. 225–237, Oct., 1908. Paper read before the Amer. Physical Soc., April 25, 1908.)—An account of the measurement of the mean wave-lengths of residual rays from rock salt, ammonium chloride, witherite, and strontianite. The source of radiation consisted of several Nernst glowers, and the rays were reflected from five surfaces besides from the mirrors of the reflection spectrometer employed, passing, in their course to a Nichols radiometer, through a fine wire grating the constant of which was 0·5082 mm. The mean wave-lengths found were: Rock salt, 52·8μ; ammonium chloride, 51·4μ; witherite (barium carbonate), 46·0μ; strontianite (strontium carbonate), 48·2μ. Attention is called to the fact that the three chlorides whose residual rays are known, viz., those of potassium, sodium, and ammonium, have bases whose atomic weights, 39, 23, and 18, lie in the same order as the wave-lengths, 61·1μ, 52·8μ, and 51·4μ. In the light of recent experiments by Pfund, Coblentz, and Morse, this series points to chlorine as the active ion in the long-wave spectrum of the chlorides. The wave-lengths of the residual rays from strontium and barium carbonates also lie in the order of the atomic weights of the respective bases. G. E. A.

1944. *Influence of Temperature and Molecular Aggregation on the Absorption Spectra of Melted Salts.* **T. Retschinsky.** (Ann. d. Physik, 27. 1. pp. 100–112, Sept. 25, 1908. Communication from the Laboratory of W. C. Heraeus.) —The absorption spectra of 80 salts have been examined at temperatures varying from 15° to 1,087° C., and it was found that the limit of absorption of melted salts with rise of temperature of 100° shifts to the red by about 10 to $20 \times 1/\mu\mu \times 10^5$. In certain cases the same shift was found with the solid salts. In some cases in the passing from the solid to the liquid state the limit of absorption shifted about $80 \times 1/\mu\mu \times 10^5$ towards the red. This the author attributes to the change in the molecular aggregation. E. C. C. B.

1945. *Wave-lengths of Standard Iron Lines.* **A. H. Pfund.** (Astrophys. Journ. 28. pp. 197–211, Oct., 1908.)—It is now generally admitted that determinations of wave-length with the diffraction grating are not suitable for fundamental or absolute measures [see Abstract No. 1848 (1904)], and after discussion of the various other methods available, the interferometer method of Fabry and Perot has been accepted. Determinations of the iron standards have been made by Fabry and Buisson [Abstract No. 1845 (1907)] and by Eversheim [Abstract No. 242 (1908)], the theory of the method being as described by Rayleigh [Abstract No. 1060 (1906)]. In the final calculations of wave-lengths Michelson's values for the red and green cadmium lines were used. A table is given showing the resulting wave-lengths of 28 iron lines between λ4282·412 and λ6494·992, the probable error being 0·004 Å.U. It is hoped to increase the accuracy of the method by various modifications in the apparatus. C. P. B.

1946. *Capacity and Current Density Effects in the Argon and Hydrogen Spectra.* **C. Sheard.** (Phys. Rev. 27. pp. 258–266, Oct., 1908.)—The change from the red to blue argon spectrum, usually associated with the introduction of capacity into the circuit, the author shows to be really due to increase in current density. In the case of hydrogen, where the fine-line spectrum is in reality the primary spectrum, and the so-called four-line spectrum is the secondary, the same is true, so that, generally speaking, the effects due to capacity may be produced by increasing the current density. E. C. C. B.

1947. *Researches on the Magnetic Resolution of Spectrum Lines.* **P. Zeeman.** (Archives Néerlandaises, 13. Nos. 3 and 4. pp. 260–290, 1908.)—An investigation of the relative intensity of certain spectrum lines when resolved by a powerful magnetic field, and also of the asymmetry sometimes observed. The two Hg yellow lines were most exhaustively examined. A vacuum tube with a central capillary portion, and containing a small quantity of mercury, was arranged with the capillary vertically adjusted between the poles of the magnet, so that the observations were made across the lines of force. By means of a lens an image of the capillary was focussed upon the slit of an anastigmatic spectroscope, so that it was possible to observe the Zeeman-effect simultaneously at different strengths of field. It was found that the relative intensity of the components of the triplets did not obey the simple law, and, moreover, that the relative intensity was materially altered by interposing plates of quartz cut perpendicularly to the axis; a similar effect was produced by turning the grating through 180° in its own plane. As previously found by the author, Hg $\lambda = 5790$ is resolved asymmetrically, the asymmetry being not far removed from linear proportionality with the field strength. This asymmetry was completely confirmed with a Fabry and Perot interferometer, and is not to be explained by a difference in the position of the middle line of the triplet from that of the original line. Asymmetrical resolutions also occur in the case of W and Mo. **E. C. C. B.**

1948. *Some Studies in Short-duration Phosphorescence.* **C. W. Waggoner.** (Phys. Rev. 27. pp. 209–222, Sept., 1908.)—The measurements were made with a specially devised phosphoroscope, the principle of which consisted in the reflection of the phosphorescent light into a spectrophotometer from a screen coated with the material under investigation. A revolving axis carried a disc with a hole in it and a small mirror; the hole in the disc allowed the light from a spark to fall on the phosphorescent screen, and by adjustment of the mirror the resulting phosphorescent light could be reflected into the spectrometer at any small interval after the moment of excitation. Several specially prepared substances were examined, and, briefly stated, the results obtained were as follows: The decay curve plotted with I^{-1} as ordinates and t as abscissæ, consists of two straight lines merging into one another. Short- and long-duration phosphorescent compounds give similar results. The curves show no discontinuity, so that the transition from fluorescence to phosphorescence is gradual. The shape of the decay curve and the intensity depend upon the time of excitation. The effect of infra-red radiation is very slight, if any at all, on short-time decay substances, but very marked on the initial decay of sidot blende. All portions of the phosphorescent band present at ordinary temperatures decay at the same rate. **E. C. C. B.**

1949. *Zeeman's Phenomenon and the Second Law of Thermodynamics.* **M. Laue.** (Phys. Zeitschr. 9. pp. 617–620, Oct. 1, 1908.)—This is a criticism of Corbino's paper on the same subject [Abstract No. 1628 (1908)]. Laue considers Corbino's problem in which two sources of radiation S_1 and S_2 are placed, S_1 in a field of magnetic force parallel to the line S_1S_2, and S_2 in a field of magnetic force perpendicular to S_1S_2. He makes first a formal objection to one of Corbino's statements, which, however, is shown to be immaterial. The substantial objection is to the intensities assumed by Corbino for the radiation from S_1 and S_2 respectively. From S_1, at which the force of the magnetic field is in the line S_1S_2, are emitted three waves of lengths λ, λ_1, and λ_2, the first longitudinally, the second and third circularly polarised in opposite directions. To this triplet Laue assigns the intensities K_l, K_{1l}, K_{2l}. From S_2 are emitted two waves circularly polarised in opposite directions; and to this doublet he assigns intensities K_{1d}, K_{2d}. The energy emitted from S_1 is then $2(K_l + K_{1l} + K_{2l})$, that from S_2, $2(K_{1d} + K_{2d})$. The energy absorbed by S_1 is $2K_l + K_{1l} + K_{2l} + K_{1d} + K_{2d}$, and by S_2 is $K_{1l} + K_{2l} + K_{1d} + K_{2d}$. The condition for equilibrium of temperature is then satisfied if $K_{1d} + K_{2d} = K_{1l} + K_{2l}$ ...(A) subject to the question whether it is applicable, which he proceeds to consider. He raises the question whether the result above given would hold for cases in which the magnetic field is very weak, and gives a proof that the magnetic field must be of a certain strength, such that the spectral lines of the doublet must have a distance from each other at least equal to the width of the central line of the triplet. For the magneto-optic effect Corbino gives the ratios $K_t : K_{1t} : K_{2t} : K_{1d} : K_{2d} :: 1 : \frac{1}{2} : \frac{1}{2} : 1 : 1$. That is $K_{1t} = \frac{1}{2}K_{1d}$, $K_{2t} = \frac{1}{2}K_{2d}$, which does not agree with A. Now according to Laue nothing in physics is more surely established than Maxwell's theory that a circular oscillation radiates twice as much energy in its plane as normal to its plane. For a system consisting of very few molecules Maxwell's law, he says, would be inconsistent with A, but such a system, he says, is excluded by the assumptions necessary to Corbino's problem; and he proves, as follows, that A necessarily holds. If, namely, $E . d\tau d\Omega d\nu$ denotes the energy emitted by the source $d\tau$ per unit of time within the solid angle $d\Omega$, with ν the number of vibrations per sec.; then he says we should have $E_{1t} : E_{1d} :: 1 : 2$, and $E_{2t} : E_{2d} :: 1 : 2$. If a denote generally the absorption coefficient for the same radiations, there falls on the surface of an opaque body radiation of the specific intensity $K = \epsilon/a$. If that passes on into vacuum without sensible reflection, it will have the specific intensity ϵ/an^2, where n is the index of refraction (which for this purpose may be taken as unity). Then he says it follows from Voigt's *Magneto-optik* that $a_{1t} : a_{1d} :: 1 : 2$, and therefore $K_{1t} : K_{1d} :: \frac{E_{1t}}{a_{1t}} : \frac{E_{1d}}{a_{1d}} = 1$. Similarly $K_{2t} = K_{2d}$, and A is satisfied. Whence he concludes that the Zeeman phenomenon is not inconsistent with the second law of thermodynamics. [See next Abstract.] S. H. B.

1950. *Emission of Light by Glowing Vapour in Magnetic Field.* **O. M. Corbino.** (Phys. Zeitschr. 9. pp. 669–671, Oct. 15, 1908. From the Italian.)—In a previous paper the author has pointed out that in the case of radiation from a glowing vapour in a magnetic field there is a contradiction to the second law of thermodynamics unless the intensity of emission is different in different directions [see Abstracts Nos. 1095, 1628 (1908)]. It is now pointed out that the light emitted normally to the direction of the magnetic field should be more intense than that emitted longitudinally, for the part whose periodicity is changed by the field will not be absorbed by the outer parts of the flame. The light longitudinally emitted is passed through two nicols and falls on the lower half of the slit of the spectroscope, while the transversely emitted light passes through a nicol and train of total reflection prisms to the upper half of the slit. By means of the nicols the intensities of the two halves are adjusted to equality with no magnetic field. On establishing the field the upper half appears the brighter, when the nicol allows the vibrations normal to the field to pass, but no change occurs on establishing the field if this nicol is 90° from the above position. Hence the transversely emitted light is the more intense, and the apparent exception to the second law of thermodynamics is thus removed [see also Laue, preceding Abstract]. S. G. S.

1951. *Chemiluminescence.* **M. Trautz.** (Zeitschr. Elektrochem. 14. pp. 453–456; Discussion, pp. 457–460, Aug. 14, 1908. Paper read before the 15 Hauptversamml. d. deutsch. Bunsen-Gesell.)—Light detectable to the eye and emitted by a body at a temperature lower than 360° is not a pure temperature phenomenon, and is termed luminescence, which is dependent on previous illumination of, or on electrical, mechanical, or chemical changes in, the radiating body. In the case of chemiluminescence, the total radiation may be less than, greater than, or as great as the dark radiation corresponding with the temperature of the body. In the second of these cases, the luminescence may be detected by the eye without measurement when the temperature is (1) below 360° and the radiation yellowish-green, or (2) between 360° and 525° and the radiation red. Most of the cases cited of luminescence at temperatures above 360° are doubtful. Many chemical reactions are accompanied by production of light, especially when they take place rapidly. Whether rise of temperature causes a greater increase in the luminescence than corresponds with the augmented velocity of reaction is, however, still doubtful. The author gives a list of luminescent reactions. The colour of the light depends only on the reacting substances, being independent of the temperature, the reaction velocity, or the presence of indifferent substances. T. H. P.

1952. *Emanations from Drying Oils.* **W. Schmidt.** (Zeitschr. Phys. Chem. 64. 2. pp. 248–250, Sept. 4, 1908.)—The gum of printed envelopes becomes insoluble and non-adhesive, and granular instead of gummy when wetted; this was traced to emanations from the printing ink. These emanations affect a photographic plate, rendering it developable in 8 or 10 days; the action is greater the higher the temperature; a solarisation effect is produced just as with light; and the emanations are stopped by glass and mica, but traverse gold-leaf, celluloid ($\frac{1}{4}$ mm. thick), sapon lacquer ($\frac{1}{8}$ mm. thick), paper ($\frac{1}{10}$ mm. thick), guttapercha ($\frac{1}{5}$ mm.), and gelatine ($\frac{1}{4}$ mm.), gelatine and paper being very transparent to them. The emanations are reflected by a metal mirror. Metal surfaces are oxidised by the impact of them and present Newton's rings: iodine starch paper becomes blue. This accounts for photographic roll film becoming affected through the celluloid by printed numbers on the paper. Traces of metals or salts accelerate the transformation of gum arabic into the insoluble form; especially chromates and iron salts. Emanations from radio-active substances do not produce this effect on gum arabic. The emanations from drying oil do not discharge an electroscope nor are they deflected by magnetic forces. A. D.

1953. *Röntgen Rays: their Absorption Law.* **W. Seitz.** (Ann. d. Physik, 27. 2. pp. 301–310, Oct. 15, 1908.)—Röntgen rays from a glass tube have had many of the softest components absorbed, and easily absorbable secondary rays at the same time developed, on transmission through the glass walls of the tube. An Al window produces less of this effect. By far the greater part of the original radiations are very absorbable, and are excited by relatively slow electrons; and these cannot traverse glass. The relatively small remainder, of constant penetrating power, which is left after transmission through about 9 tin-foils (0·0177 mm.) or 20 Al sheets (0·0192 mm. each) consists of those rays which are produced when electrons are retarded before they have lost their velocity in metal. The radiations from the tube consist of longer and shorter impulses. For Al the shorter these impulses are, the greater the penetrating power, but silver presents a minimum penetrating power at medium impulse-lengths. Like Al, silver absorbs the longest impulses, and on the whole makes the aggregate radiations harder [*contra* B. Walter, Abstract No. 1870 (1905)] as Al does; but as it stops the shortest impulses, which pass with special readiness through Al, the absorption in Al is less reduced than that in silver. There is no necessity to infer, as B. Walter does, any transformation of the radiations on their passage through Al or silver. The penetrating power increases continuously, but slowly, with the p.d.; and the minimum of penetrative power tends to be masked by the presence of very soft radiations. **A. D.**

1954. *Homogeneous Secondary Röntgen Radiations.* **C. G. Barkla** and **C. A. Sadler.** (Phil. Mag. 16. pp. 550–584, Oct., 1908. Paper read before the Physical Soc., June 12, 1908.)—An account of recent experiments on the homogeneous secondary radiations is given in this paper and also a general discussion of the phenomena of secondary Röntgen radiations summarising the results already published by Barkla in previous papers [Abstracts Nos. 58, 628, 782, 785 (1908)]. It has been found to hold generally that all substances subject to Röntgen rays are a source of secondary Röntgen rays. The radiation from a given element is independent of the physical state of the substance and of its mixture or even chemical combination with other elements. The character of the secondary radiation from an element is independent of the intensity of the primary radiation producing it. The intensity of secondary radiation from an element is proportional to the intensity of the primary radiation of definite character producing it. The absorption by a thin sheet of any substance of the secondary rays from various elements subject to the same primary beam is a periodic function of the atomic weight of the radiating substance. The results of the experiments in the case of substances of low atomic weight when an easily absorbed primary is used as the exciting beam may be explained by the theory given by J. J. Thomson. The electric displacement in the primary Röntgen-pulses when passing over the electrons produces accelerations in these in the direction of that displacement, and thus causes the emission of secondary pulses of equal thickness. It is concluded from the series of experiments described in this and previous papers that secondary Röntgen rays of two distinct types are emitted by substances subject to a beam of Röntgen rays—one a scattered radiation produced by the motion of electrons controlled by the electric force in the primary Röntgen pulses; the other a homogeneous radiation characteristic of the element emitting it, and produced by the motion of electrons uncontrolled by the electric force in the primary pulses. All the observed phenomena of secondary Röntgen rays may be explained by means of these two. Some of the chief experimental results obtained are as follows: Scattered Röntgen rays—the first type mentioned above—constitute the bulk of the secondary radiation from elements of the H-S group when these are subject to a primary beam of low to moderate penetrating power. Scattered Röntgen rays are also emitted by many elements of higher atomic weight when subject to such a primary beam; but unless the primary is very soft they are accompanied by homogeneous secondary Röntgen rays (characteristic of the radiating element) which produce much greater ionisations. In the case of elements of the H-S group the intensity of the scattered radiation from an atom is proportional to its atomic weight. From some elements of higher atomic weight the intensity is greater than would be given by this law. The penetrating power of the homogeneous radiation from each element examined is independent of the intensity or the penetrating power of the primary radiation producing it. It is a periodic function of the atomic weight of the radiating element, and is more easily absorbed than the primary radiation which gives rise to it. It is concluded that the nature of the homogeneous rays is similar to that of the primary Röntgen rays, and is set up by disturbance of electrons produced directly or indirectly by the passage of the primary pulses. It appears to be due, not to any disruption in the atom, but to what may be regarded as normal behaviour of an atom after it has been passed over by Röntgen pulses, such as a free vibration of electrons. According to the theory energy is taken from the primary beam, and part at least appears as secondary homogeneous radiation, the rest being transformed into heat. J. J. S.

1955. *β-Ray Spinthariscope.* **E. Regener.** (Deutsch. Phys. Gesell., Verh. 10. 9. pp. 351–353, May 15, 1908.)—A screen of barium platinocyanide, exposed to the β-rays of radium, shows fugitive bursts of luminosity which occasionally appear to consist of discrete points. A single point is probably produced by several concurrent electrons, as the brightness of the point produced by a single electron is below the limit of distinct vision. When the eye is thoroughly rested the scintillation may be observed as far as 40 or 50 cm. from the screen. All phosphorescence is probably due to scintillation, and the author is endeavouring to test this by counting methods. E. E. F.

1956. *Uranium and Radium.* III. **F. Soddy.** (Phil. Mag. 16. pp. 632–638, Oct., 1908.)—Describes further researches on the relation between uranium and radium [see Abstracts Nos. 1585 (1905) and 1642 (1907)]. The results of the second series of experiments have confirmed the original experiment, started in 1903, in showing the existence of a radium-producing substance in minute amount in commercial uranyl salts. The amount is, in the specimens tested, always below one part in a thousand of the theoretical equilibrium amount which should be present in the natural mineral. The main part by far of the parent of radium in minerals is probably contained in the mother-liquors from the crystallisation of the uranium salts, and so is lost. In the carefully prepared uranium salts prepared by T. D. Mackenzie in 1905–6, the growth of radium in one case is not greater than 5×10^{-11} gm. per kg. of uranium in 2¼ years, and in the other it is not above 10^{-11} gm. per kg. of uranium in 1⅓ years. It can be shown from these data that if there exists only one long-lived intermediate body between uranium and radium, its period of average life must not be less than 16,500 years, or six times that of radium; so that at least six times more of it than of radium must exist in minerals. If there be two such bodies, the product of their periods must be at least 10,000 years; and if they are equal each must not be less than 100 years. A. W.

1957. *Radiation from Uranium X.* **M. Levin.** (Phys. Zeitschr. 9. pp. 655–657, Oct. 15, 1908. Inst. f. physikal. Chemie, Göttingen, Aug. 28, 1908.)—It was previously shown [Abstract No. 1835 (1907)] that the easily absorbed rays emitted by UrX besides the penetrating β- and γ-rays are β-rays and that the substance sends out no α-rays. This conclusion has been confirmed, and the form of the curves obtained when the intensity of ionisation and the distance between source of radiation and the ionisation space are graphically represented, indicates that the phenomena observed are due to diffusion effects. The ionisation enclosure was shut off below by a wire gauze joined to earth. The position and character of the maximum of ionisation as shown on the curves depended on the width of the meshes of the gauze and hence on the number of ions entering the observation enclosure. With increasing closeness of the meshes the maximum point shifted to a smaller distance and at the same time became sharper. The appearances remained even when a piece of tin-foil sufficiently thick to cut off any α-rays which might be present was interposed. In general the curves show at first an increase of the ionisation with increasing distance between source and ionisation chamber, followed by a decrease, except when a sheet of Al is used to close the ionisation space below, when there is a continuous decrease. This is what may be expected if easily absorbed β-rays are present, for then there would be an especially pronounced falling-off at small distances from the radiating substance.

J. J. S.

1958. *Range and Absorption of the α-Rays.* **E. Aschkinass.** (Ann. d. Physik, 27. 2. pp. 377–390, Oct. 15, 1908. Physikal. Inst. d. techn. Hochschule, Berlin, July, 1908.)—The transmissibility of α-rays through sheets of Al was measured by observing the increase in charge of an electrometer produced by α-rays from polonium which passed through different thicknesses of Al. The α-particles passed in undiminished number through thin layers of the metal. With a sheet of Al 13·72 μ thick no absorption was noticeable. Between 13·72 and 17·15 μ it is first observed, and is total at 24·3 μ. The α-particles from polonium have been found by previous observers to possess an initial velocity of 1·67 × 10⁹ cm./sec., and their zone of action extends to 3·86 cm. in air. A layer of Al 23·4 μ thick is equivalent to this thickness of air. The results of the author's observations do not agree with the hypothesis that the α-particles beyond the critical velocity value of 0·82 × 10⁹ cm./sec. in matter gradually come to rest; they, on the contrary, are in accordance with the assumption that the particles suddenly stop as soon as their velocity has fallen to that critical amount. It is thus not necessary to assume that the α-rays must possess a definite minimum velocity in order to ionise gases, to excite fluorescence, and to produce chemical changes. The non-appearance of these effects beyond the range of action finds its explanation rather in this, that the α-particles remain fixed after passing through a certain thickness of the material, which is determined by their critical velocity and the nature of the absorbing substance. In an appendix the author describes some experiments on the secondary radiation excited by the α-particles. J. J. S.

1959. *Range of the α-Particle.* **S. J. Allen.** (Phys. Rev. 27. pp. 294–321, Oct., 1908.)—Experiments were carried out to investigate the range and total ionisation of the α-particle from radium, thorium, and uranium. The excited activity of the atmosphere was also dealt with, and the following are the conclusions reached: (1) The distance between two parallel plates for max. current, due to the ionisation caused by a uniform layer of radio-active material on the lower plate, bears a definite relation to the max. range of the α-particle from the surface of that substance. (For RaC the range is 7·1 cm.) (2) When the rays are allowed to emerge in all directions to the normal, this max. position is much less than the range of the particle, being roughly one-half. (3) When the oblique rays are cut off in any manner the position of max. current increases with the value of the range, and for normal projection is equal to it. (4) There seems to be a further decrease of current with increasing distance between the plates, even after apparent saturation is reached. (5) If maximum positions of current for two radio-active substances are observed, and the range of one is known, then the range of the other can be calculated from the ratio of the maximum positions. (6) If layers of absorbing material are placed over the radio-active substance the position of max. current decreases proportionally to the decrease of the range, and from this decrease the stopping power may be calculated with results agreeing very well with those of Bragg, *e.g.*, the mean value found for the stopping power of Al is 1·33, the value obtained by Bragg being 1·23. (7) The max. range of the α-particle from the excited activity of the atmosphere is the same as that of RaC, which indicates that a great part of the excited activity of the atmosphere is always RaC, being often mixed with a portion of thorium-excited and the other products of radium. The method used in the experiments is especially adapted to radio-active substances of low activity. J. J. S.

1960. *The Nature of the α-Particles.* **E. Rutherford.** (Nature, 79. pp. 12–15, Nov. 5, 1908.)—A summary of some recent experimental work on the α-particles [see Abstracts Nos. 1627 and 1628 (1908)]. The α-particle appears to be an atom of helium carrying a double charge, or an α-particle when its charge is neutralised is a helium atom. The calculated rate of production of helium by radium is 0·43 mm.^{3} per day. This agrees well with the value found experimentally by Dewar, 0·37 mm.^{3} per day [Abstract No. 1808 (1908)]. The calculated heating effect of radium per gm. is 113 gm.-cals. per hour, and the value found for the period of transformation of radium is 1,750 years. J. J. S.

1961. *A New Product of Actinium.* **O. Hahn** and **L. Meitner.** (Phys. Zeitschr. 9. pp. 649–655, Oct. 15, 1908. Chem. Inst. d. Univ., Berlin.)—It was observed that the decrease of the activity of the active deposit of actinium occurred more slowly at first than would be expected from the known values of the decay periods of actinium A and actinium B. A series of experiments on the activity and the decay of the activity of the products of actinium was made, and the presence of a new product, actinium C, was proved. Thus it is now shown that the active deposit of actinium consists of three well-characterised, quickly decaying products, Ac A, B, and C. The decay period of the new product was found to be 5·10 min. It sends out the β- (+ γ-) rays hitherto ascribed to Ac B: it emits, however, no α-rays. It was found that the α-rays of the active deposit were sent out only from Ac B. This was separated from Ac A, and its decay newly determined by direct measurement. The period was found to be 2·15 min., in full agreement with the value calculated by Bronson. The active deposit of Ac is thus shown to consist of the following products: (1) Ac A sending out very easily absorbed β-rays, and having a decay period of 36 min. (2) Ac B sending out α-rays, its decay period being 2·15 min. (3) Ac C sending out β- (+ γ-) rays, decay period 5·10 min. The theoretical β-curve for the rise of Ac B free from Ac C, as well as that for the α- and β-activity of the active deposit, were compared with those obtained from experiment, and found to be in good agreement. J. J. S.

1962. *The Production of Helium.* **F. Soddy.** (Phil. Mag. 16. pp. 513–530, Oct., 1908.)—The object of the experiments described was to obtain a quantitative estimate by the spectroscope of the amount of helium produced from uranium and thorium, or in the event of negative results to fix a definite limit to the quantity of helium that could not fail to have been detected under the conditions. The process recently described by the author for the detection and measurement of infinitesimal quantities of helium has been exclusively used. It depends on the use of calcium heated to its volatilisation point in a specially constructed vacuum electric furnace. The rate of production of helium from uranium and thorium at present indicated by theory is about 2×10^{-12} per year as a minimum value if it is produced at all, or about $4{\cdot}4 \times 10^{-12}$ per year, calculated by an indirect method on the assumption that the α-particle is an atom of helium. The minimum quantity of helium detectable by the spectroscope by the special methods employed has been shown to be two tenth-grammes (10^{-10} gm.), and with the quantities of uranium and thorium employed in the experiments a period of accumulation of several months is necessary to detect the helium if produced at the theoretical rate. Only one positive result has so far been obtained. With 850 gm. of thorium in the form of nitrate, helium to the extent of about two tenth-grammes was detected after a period of accumulation of nearly 7 months, which corresponds with a rate of helium production of 2×10^{-10} per year. This result is of no significance until it is confirmed. All the other tests so far obtained only indicate that the rate of production of helium from both uranium and thorium is certainly below what was first deduced from the imperfect theory, and is certainly not above the rate indicated by the present theoretical data. J. J. S.

1963. *β-Rays of Actinium.* **O. Hahn** and **L. Meitner.** (Phys. Zeitschr. 9. pp. 697–702, Oct. 25, 1908. Chem. Inst. d. Univ., Berlin, Sept., 1908.)—The disintegration products of actinium contain, not as hitherto supposed, one β-ray product only, but three, viz., radio-actinium, actinium A, and actinium C. The β-rays of radio-actinium are half absorbed in about 0·04 mm. of Al, those of Ac C in 0·24 mm. In the case of radio-actinium still another penetrating radiation was observed, but it is not yet certain whether it is due to very hard β-rays or very soft γ-rays. The previously made assumption of the authors [see Abstract No. 1098 (1908)] that simple products also send out simple β-rays, and that the absorption of these in aluminium follows an exponential law has been verified as a working hypothesis in the case of actinium, and has led to the discovery of the new group of β-rays. The observed increase of the absorption coefficient, with increasing thickness of the absorbing sheet, depends very much on the penetrating power of the different β-rays, and can in all cases be made to disappear by suitable arrangements. J. J. S.

1964. *Radium Emanation in Atmosphere.* **J. Satterly.** (Phil. Mag. 16. pp. 584–615, Oct., 1908.)—The author summarises the work of other experimenters on this subject and then proceeds to describe at considerable length the results of researches carried out at Cambridge. Two methods of measurement were employed: (i) absorption by charcoal and (ii) condensation by liquid air, and the amounts obtained by these methods were compared with those given off by a radium solution of known strength. The two methods give results in fairly close agreement. They show that the amount of emanation in 1 cub. m. of air is subjected to considerable variation, and is, on the average, equal to that amount which would be in radio-active equilibrium with about 100×10^{-12} gm. of radium. No very definite correlation could be established between the changes in the weather and barometer during the period through which the experiments were performed. The above quantity of radium emanation, together with its disintegration products, would produce about 3 ions per cm.^{3} per sec. As the number of ions actually produced per cm.^{3} per sec. is about ten times this, it follows that only a small proportion of the natural ionisation of the air is due to the presence of the radium emanation and its products. A. W.

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1965. *Gadsden's Artificial Horizon for Sextants.* **H. H. Turner.** (Roy. Astronom. Soc., Monthly Notices, 68. pp. 535–536, May, 1908.)

1966. *Movable Stage for Stereoscopic Microphotography.* **F. Kamieński.** (Acad. Sci. Cracovie, Bull. No. 7. pp. 651–655, July, 1908.)—The most convenient form is a round stage capable of rotation around the optic axis of the microscope. The central part can be turned round a horizontal axis through its centre to expose two slightly different aspects of the object to the camera. G. E. A.

1967. *Improvements in the Vierordt Double-slit Method.* **H. Krüss** and **P. Krüss.** (Zeitschr. Instrumentenk. 28. pp. 296–301, Oct., 1908.)—Description of instrument details.

1968. *The Bi-quartz Wedge Plate applied to Polarimeters and Saccharimeters.* **F. E. Wright.** (Amer. Journ. Sci. 26. pp. 391–398, Oct., 1908.)

1969. *Wave-length Measurements for the Establishment of a System of Spectroscopic Standards.* **C. Fabry** and **H. Buisson.** (Astrophys. Journ. 28. pp. 169–196, Oct., 1908. Translation.)—[See Abstract No. 775 (1908).]

1970. *Flame Spectrum of Copper Chloride.* **P. Kien.** (Zeitschr. wiss. Phot. 6. pp. 337–358, Oct., 1908.)—A complete study of the flame spectrum of $CuCl_2$ carried out partly with a 1-m. focus grating and partly with a 6·5-m. focus grating. The measurements of the bands and lines are given in the paper, and Deslandres' third law was found to hold good for the heads of the bands. E. C. C. B.

1971. *A Study of the Spectrum and the Bromides of Niobium.* **W. M. Barr.** (Amer. Chem. Soc., Journ. 30. pp. 1668–1672, Nov., 1908. Contribution from the John Harrison Lab. of Chemistry.)—A spectroscopic investigation of various preparations of Nb_2O_5 from different localities was carried out and showed that they all give the same spectrum provided that they have been sufficiently purified. The few lines common to Nb_2O_5 and TiO_2 are thus shown to be chance coincidences. [See next Abstract.] E. C. C. B.

1972. *Arc Spectrum of Niobium.* **J. H. Hildebrand.** (Amer. Chem. Soc., Journ. 30. pp. 1672–1684, Nov., 1908. Contribution from the John Harrison Lab. of Chemistry.)—The author has measured the arc spectrum of Nb between λ2600 and λ6000, using a concave grating of 6-ft. focus, and the complete list of lines is given in the paper. [See preceding Abstract.] E. C. C. B.

1973. *Zeeman-effect in Spark Spectrum of Iron.* **Mme. H. B. van Bilderbeek-van Meurs.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 222–225, Oct. 28, 1908.)—Tables of the separations produced on the lines of the spark spectrum of iron in the region λ2380–λ4416. Photographs of the spectra were obtained with a concave Rowland grating 8 cm. wide, 304·96 cm. radius of curvature, having 14,438 lines to the inch. A magnetic field of about 30,000 Gauss was employed. C. P. B.

1974. *Radio-activity of Water from Goitrigenous Sources.* **Répin.** (Comptes Rendus, 147. pp. 387–388, Aug. 17, and pp. 703–705, Oct. 19, 1908.)—Points out that the water from a number of sources which are admittedly goitrigenous is markedly radio-active, and speculates upon a possible connection between the active constituents and the disease. L. H. W.

HEAT.

1975. *Mechanical Equivalent of Heat.* **V. Crémieu and L. Rispail.** (Comptes Rendus, 147. pp. 793–795, Nov. 2, 1908.)—In the direct determination of the mechanical equivalent of heat, errors arise from the fact that a constant temperature is not usually employed. In the method employed by the authors, the transformation from work to heat is effected in the muffle of a Bunsen calorimeter, in which the temperature may be maintained for several hours rigorously equal to that of melting ice. The stirrer is driven by an electric motor, and a dynamometer is used to measure the turning moment. The whole system is suspended and is rendered aperiodic by means of a special damping arrangement previously described [see Abstract No. 1829 (1905)]. The final mean value obtained for J is $4{\cdot}1851 \times 10^7$, with a probable error not greater than 0·0027. A. W.

1976. *Specific Heats of Barytes, Witherite, and Fused Lime.* **Latschenko.** (Comptes Rendus, 147. pp. 58–61, July 6, 1908.)—The method of mixtures was used with water or (in the case of the lime) petroleum in the calorimeter. The specific heat of native barium sulphate increases at first regularly from 0·114 at 150° to 0·129 at 500° and then remains practically constant at 0·13 between 500° and 1,050° C. Witherite is known to undergo a molecular transformation at about 800°; this transformation is accompanied by an absorption of 19 cals. per gm. of substance and by a marked change in specific heat. The specific heat of witherite changes from 0·116 at 250° to 0·130 at 800°, 0·143 at 810°, 0·162 at 1,030°. Lime undergoes a molecular transformation at 405°–410°, accompanied by an absorption of 5 cals. per gm. The specific heat curve is similar in character to that of witherite. D. H. J.

1977. *Apparent Deviations from Boyle's Law.* **K. Scheel and W. Heuse.** (Phys. Zeitschr. 9. pp. 784–787; Discussion, pp. 787–788, Nov. 1, 1908. Paper read before the 80. Naturforscherversamml., Köln. Deutsch. Phys. Gesell., Verh. 10. 20. pp. 785–793, Oct. 30, 1908.)—Referring to the experiments of Baly and Ramsay, who observed an apparent departure from Boyle's law in the case of rarefied air compressed in a McLeod manometer, and those of Hering who also observed that the law seemed not to hold for air compressed in capillary tubes of a width of about 0·7 and 1·5 mm., the authors have investigated the behaviour of air at pressures of less than 1 mm., using a manometer like that employed by Rayleigh [Abstract No. 1652 (1901)]. The results of the experiments indicate that the apparent deviations of air from Boyle's law depend on the formation of a skin of water on the interior surfaces of the compression vessels. When this water-film is removed the discrepancies disappear. Further experiments were made to test the behaviour of the McLeod manometer, and these show that the instrument is well adapted for the exact measurement of small pressures in atmospheric air, provided that all moisture is carefully removed from the air and from the glass surfaces. J. J. S.

1978. *Thermometric Properties of Alkali-free Glass* 477^{III}. **H. F. Wiebe.** (Zeitschr. Instrumentenk. 28. pp. 293–296, Oct., 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—This alkali-free glass of the Jena firm has a remarkably high electrical insulating value, and very low thermal time-effect. Though refractory, it works well, hence two thermometers were made of it, and studied by the author. The zero depression due to heating to 100° was only 0·014°, which is the best yet found for any glass. The reduction formula (mean of the two thermometers) to hydrogen thermometer temperatures, t, is $t - t' = +0{\cdot}00000886\,(100 - t')t' - 0{\cdot}000000589\,(100 - t')^2t'$. The corrections are thus rather greater than for glasses 59^{III} and 122^{III}. The coefficient of cubical expansion between 0° and 100° is, according to F. Hoffmann, 0·00001482, that for 59^{III} being 0·00001769. The drawback to its use in thermometry is that it has a tendency to crack spontaneously. F. R.

1979. *New Gas Thermometer Measurements.* **A. L. Day** and **J. K. Clement.** (Amer. Journ. Sci. 26. pp. 405–468, Nov., 1908.)—It is considered that the soundness of fundamental principles of gas thermometry has been sufficiently established, and it remains to increase the accuracy and the range of measurements. The author's object was to increase the accuracy of the scale between 250° and 1,150°, the present error between 800° and 1,150° being probably 5°. The Pt-Ir (10 per cent.) bulb constant-volume nitrogen thermometer was used, with the same general principle of arrangement as used at the Reichsanstalt. The heating coils were grouped so as to give a high degree of uniformity of temperature along the bulb. The furnace was enclosed in a gas-tight vessel, with nitrogen within and outside the bulb at uniform pressure at all temperatures. This has the advantages of preventing deformation of the bulb, and diffusion through its walls, and of allowing considerable variation of initial pressure, thus increasing the value and sensitiveness of the manometer. The sensitiveness was thus about three times that of the Reichsanstalt arrangement. The expansion of the material of the bulb was determined with an accuracy probably within ½ per cent. The relative space unheated between bulb and manometer has been reduced to about ⅓ the amount previously attained, the total correction for this space being less than 5° at 1,100°. It is believed that the aggregate error of the gas thermometer at about 1,100° has by these means been reduced to about 0·5°, and it is reasonably probable that the scale can be extended with proportionately small error to 1,500° or 1,600° in a similar manner. This the authors are undertaking immediately. The reproduction of the scale, however, cannot as yet be placed on a satisfactory basis, as the variations in commercial "pure" metals are such that at the higher temperatures an accuracy within 1° cannot be assured. The following are the most probable values of the melting-points: Zn, 418·5° ± 0·1°; Ag, 958·8° ± 0·5°; Au, 1,059·8° ± 1·0°; Cu, 1,081·0° ± 0·5°. The origin, and analysis (except of gold) of each sample is stated. The error of interpolation between Zn and Ag may amount to 2°. It is hoped that sufficiently trustworthy intermediate points may yet be found. F. R.

1980. *Table giving Approximate Moisture in the Air for the Temperatures 40°–100°.* **J. Disch.** (Zeitschr. Instrumentenk., Beib. 19. pp. 181–182, Oct. 1, 1908.)—The author prepares a table giving the approximate humidity of the air for temperatures from 40° to 100°. The table is prepared by means of the formula $e'' = e' - A(t - t')b$, where t and t' represent the temperatures of the dry and wet thermometers respectively, b the atmospheric pressure, e' the pressure of saturated water-vapour at t', e'' the vapour pressure at the time of observation, and A a constant having the values 0·0012 for still air, 0·008 for gently moving air, and 0·000656 for rapidly moving air. This expression, which agrees well with the experimental numbers obtained in the temperature interval, −80° to +40°, gives values which are the more inaccurate as the temperature becomes more distant from 40°. T. H. P.

1981. *Evaporation of Solutions.* **P. Vaillant.** (Comptes Rendus, 146. pp. 811–814, April 13, 1908.)—Measures the amounts p and p' evaporated in the same time by pure water of tension F and sulphuric acid solution of tension F′. The ratio $B = (p - p')/(F - F')$ is independent of the concentration of the solution. The mean value of B is 0·701 mgm. for the solution. This is the value when the liquid touches the edge of the vessel. When the liquid is 25 cm. below the edge, B may be as low as 0·896, especially when the solution of sulphuric acid is concentrated. [See Abstract No. 814 (1908).] E. E. F.

1982. *Over-cooled Water.* **B. Weinberg.** (Nature, 78. p. 390, Aug. 27, 1908.)—A piece of ice is placed in a finely drawn-out glass tube, and then introduced into over-cooled water. When the crystallisation reaches the lower end of the tube, an ice-crystal having the shape of a hexagonal star, and very similar to the characteristic snow crystals, begins to grow. The greater the over-cooling, the greater is the abundance of ramifications and the velocity of crystallisation. When a star is broken, the pieces of it rise horizontally in the water. This can explain the verticality of optic axis of river- and lake-ice. E. E. F.

1983. *Kinetic Molecular Energy.* **C. P. Steinmetz.** (Amer. Electrochem. Soc., Trans. 13. pp. 397–423; Discussion, pp. 424–427, 1908.)—Gives a tentative outline of a mechanical thermodynamics. It is possible to derive the laws of thermodynamics from the law of central forces acting between molecules and atoms, without any other assumption as regards shape or elasticity of molecules, and without introducing the conception of entropy. Thermodynamics thus becomes the dynamics of irregular mechanical or molecular motion, and heat disappears as a distinct form of energy. Hereby not only the anomalies of gases due to finite size, polymerisation, dissociation, &c., may be explained, but it is even possible to calculate the numerical values of these deviations. E. E. F.

REFERENCES.

1984. *Use of Quartz Tubes for Pyrometers.* **P. Schoen.** (Metallurgie, 5. pp. 685–687, Nov. 8, 1908. Communication from the Metallograph. and Metallurg. Laborat. d. Königl. Bergakademie, Freiberg.)—The author recommends the use of quartz in preference to porcelain thermo-couple tubes, where possible, on the grounds that they are impermeable to many gases, they are cheaper, and, above all, they are less liable to mask heat evolutions. Instances are given to show their superiority in the third respect. F. R.

1985. *Kinetics and Thermodynamics of Mixtures.* **H. Happel.** (Ann. d. Physik, 26. 1. pp. 95–119, May 12, 1908.)—A theoretical consideration.

1986. *A Commentary on the First Law of Thermodynamics.* **J. E. Trevor.** (Journ. Phys. Chem. 12. pp. 297–317, May, 1908.)

SOUND.

1987. *Apparatus for Recording Waves in Air Pressure.* **W. Schmidt.** (Ann. d. Physik, 27. 2. pp. 346–358, Oct. 15, 1908. K.K. Zentral-Anstalt f. Meteorol. u. Geodynamik, Wien.)—Describes an apparatus which records regular waves or variations in air pressure of a given frequency, quicker or slower variations being more or less suppressed. The apparatus, in its finally adopted form, consists of two flasks, each of about 400 c.cm. capacity, connected by rubber bungs and a glass tube, with cock to equalise the pressure inside and out, a second tube connected with capillaries for checking very sudden changes of pressure, and the Toepler pressure chamber, which is introduced between the flasks. Various records are given, showing fairly regular wave-form variations in the atmospheric pressure of periods varying from about ½ min. to 6 min. E. H. B.

1988. *Vibrations of a Drum.* **T. Terada.** (Mathematico-Physical Soc., Tōkyō, Proc. 4. 17. pp. 345–350, June, 1908.)—The author, in examining the behaviour of a Japanese toy drum, *Taiko*, which has two membranes, observed that the principal tones of the drum are considerably affected in pitch by approaching a wall with the membrane opposite to that struck. This led him to investigate the behaviour of a pipe with a membrane at one end and afterwards of a closed pipe, each end being a membrane. He thus concludes that the drum may be considered as an example of a connected system of vibrating bodies with two degrees of freedom. In one normal mode of vibration the two membranes vibrate in the same phase together with the air between them, which is not appreciably changed in density. In the other mode the membranes vibrate in opposite phases, the air between them undergoing marked compression. A drum from New Guinea is also dealt with. This consists of a hollow wooden pipe, quasi-cylindrical but contracted in the middle, one end open, the other closed with a lizard skin. The gravest tone and the next have frequencies of about 80 and 240 per sec. respectively.

E. H. B.

1989. *Acoustical Notes.* **Rayleigh.** (Phil. Mag. 16. pp. 235–246, Aug., 1908.)—The partial tones of stretched strings of variable density is the first subject treated in these notes, and an account is given of experiments in general confirmation of the author's theory ("Theory of Sound," 2nd ed., § 140). The maintenance of vibrations of a tuning-fork by the impact of water-drops from a jet in connection with the fork's stem is next noticed. An instrument called the *acousticon* is described, intended to aid the hearing of the partially deaf. It is composed of a simple battery, microphone, and telephone circuit. The microphone is unusually efficient. The disc which receives the sound is of carbon, about ½ mm. thick, and is clamped at the circumference. Bearing against it are six groups of small carbon spheres (½ mm.) having the appearance of shot, held in hemispherical cups cut out in a thick plate of carbon. The consonants were well rendered, but *f* was not distinguished from *s*, thus in counting *sive*, *fix*, were heard as five, six. As to the pitch of sibilants, experiments by nodes and loops gave the wave-lengths of two hisses as 25 mm. and 32 mm. respectively, the frequency being of the order 10,000 per sec., more than five octaves above the middle *c*. Some miscellaneous experiments upon telephones are also recorded, condensers being introduced with the hope of improving the articulation of the sibilants.

E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1990. *Electromagnetic Effects in Moving Bodies.* **H. Minkowski.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 1. pp. 53–111, 1908.)—Lorentz's theorem of relativity, hitherto applied to electromagnetic problems only, may be converted into a postulate of relativity applicable to all systems of mechanics, just as the law of the conservation of energy becomes a postulate if certain forms of energy are still unknown. The author formulates the Principle of Relativity by showing how the equations for moving bodies, when subjected to a Lorentz transformation, are converted into the corresponding equations for the transformed quantities. This formulation puts the fundamental equations into a perfectly definite form. No equations hitherto put forward are quite in accordance with the Principle, not even Lorentz's own general equations, which include the case of magnetised bodies. The Principle of Relativity requires a new definition of time, or rather of the "simultaneous" occurrence of two events. If four points in space, not in the same plane, are considered at a given time, the time parameter cannot be altered by a Lorentz transformation without affecting the simultaneousness of the four space-time points defined by the values of x, y, z and t. This restriction does not apply when the number of points is less than four. E. E. F.

1991. *Electromagnetic Theory of Moving Bodies.* **A. Einstein** and **J. Laub.** (Ann. d. Physik, 26. 8. pp. 532–540, July 7, 1908.)—An elementary deduction of the equations propounded analytically by Minkowski [see preceding Abstract]. Two systems of co-ordinates, K and K′, are introduced, both free from acceleration, but movable with respect to each other. If matter is contained in space which is at rest with respect to K′, the Maxwell-Hertz equations apply also with respect to K′. If these equations are transformed to the system K, we obtain at once the electrodynamic equations for moving bodies if the velocity of the matter is constant in time and space. These new equations are obviously valid to a first approximation when the distribution of speeds is arbitrary. They are strictly valid when the bodies are not accelerated, and are separated by vacuum intervals.

E. E. F.

1992. *Dynamics of a Rigid Electron.* **A. W. Conway.** (Roy. Irish Acad., Proc. 27. Section A. pp. 169–181, Feb., 1908.)—By a method of continued approximation the author finds for a rigid electron that no expression for the electromagnetic mass of a spherical shell is more correct than the simplest one, $2e^2/3a$, and that the general expression for the back pressure due to radiation is not more correct than the simplest one, $2e^2\dot{v}/3u^3$, where v is the speed of the electron and u that of light. E. H. B.

1993. *Experimental Confirmation of Lorentz-Einstein Theory by Becquerel Rays.* **A. H. Bucherer.** (Phys. Zeitschr. 9. pp. 755–760; Discussion, pp. 760–762, Nov. 1, 1908. Paper read before the 80. Naturforscherversamml., Köln.)—Repeating one of Kaufmann's experiments as to the deflection of the electrons in an electric and magnetic field, with special precautions to obtain the best possible results as to the values of e/m_0 at high velocities, the author finds values which he claims to be a confirmation of the Lorentz-Einstein principle of relativity. The close agreement of the results on this principle are shown in the following table, in which β denotes the ratio of the speed of the electron to that of light, the magnetic fields used being of the order 127 gauss:—

β.	Values of $(e/m_0) \times 10^{-7}$ on Theory of—	
	Maxwell.	Lorentz.
0·3792	1·678	1·730
0·4286	1·670	1·730
0·5160	1·648	1·729
0·6879	1·578	1·730

[See also Abstract No. 1851 (1907).] E. H. B.

1994. *Electron Theory of Metals.* **P. Gruner.** (Deutsch. Phys. Gesell., Verh. 10. 13. pp. 509–536, July 15, 1908.)—Assumes a single species of free electrons, and applies the conceptions and methods of Lorentz, including impact of the electrons upon molecules only, Maxwell's law of distribution, and elasticity of impact. But in addition the author assumes the existence of positive metallic molecules as well as neutral ones. The former may bind or absorb free electrons when their velocity falls below a certain value, and the latter may be ionised when the velocity exceeds that value. Otherwise the impact is perfectly elastic. These new assumptions enable us to explain the galvanic and thermal phenomena in metals on the sole ground of moving negative electrons. In the steady state as many electrons are liberated by ionisation as are absorbed by positive molecules. These ideas are put into a mathematical form on the general lines of Lorentz's equations. The Hall-effect anomalies are covered by the variable proportion between positive and neutral molecules. The deviations from Wiedemann and Franz's law are also embraced, and useful formulæ are obtained for voltaic and thermo-electric e.m.f.'s, and for the Thomson-effect. E. E. F.

1995. *Bjerknes' Hydrodynamical Analogy.* **G. Gianfranceschi.** (N. Cimento, 15. pp. 429–439, May, 1908.)—Considers in detail the case of two spheres pulsating periodically by expansion and contraction, and immersed in an incompressible liquid. Flux then corresponds to velocity, field strength to specific moment, and inductivity to mobility. An extension of the principle of Archimedes may be formulated as follows: A body which participates in the translatory motion of a fluid is subjected to an impulse equal to the product of the acceleration of the translatory motion into the mass of water displaced by the body. The author shows that when two bodies pulsate or oscillate in the same phase there is an apparent attraction between them. When they are in opposite phases there is an apparent repulsion. The analogy with electromagnetic phenomena thus suffers under a reversal of sign. But this objection also attaches to the method of images when displacement parallel to the mirror is considered. E. E. F.

1996. *Ponderomotor Forces in an Electromagnetic Field.* **A. Einstein and J. Laub.** (Ann. d. Physik, 26. 8. pp. 541–550, July 7, 1908.)—An objection to Minkowski's theory consists in the deduction from his equations that a body traversed by a polarisation current instead of a conduction current experiences no force in a magnetic field. This implies that a conductor cannot be regarded as a dielectric of infinite specific inductive capacity. The authors deduce, by electronic methods, the ponderomotor forces on any magnetisable bodies at rest. These obey the law of equality of action and reaction. E. E. F.

1997. *Atmospheric Electricity Observations on the "Galilee" in the Pacific, 1907–1908.* **P. H. Dike.** (Terrestrial Magnetism, 13. pp. 119–128, Sept., 1908.)—The magnetic survey yacht *Galilee* proved unsuitable for potential gradient determinations, as a sailing ship is not steady enough; only one observation was taken, which gave a very unsteady potential of the usual order of magnitude. Radio-active observations were interrupted by a breakdown in the apparatus; near Alaska and in Cook Strait (New Zealand) radio-activity of the air was observed, not on the open sea. Evaporated rain-water did not show signs of radio-activity. The Gerdien apparatus for determining the conductivity of the air worked satisfactorily; it was the apparatus already used by Burbank in Labrador [see Abstract No. 108 (1908)]. The specific conductivity of the air gave the mean values $\lambda_p = 1{\cdot}608 \times 10^{-4}$, $\lambda_n = 1{\cdot}488 \times 10^{-4}$; the ratio $\lambda_p/\lambda_n = 1{\cdot}12$. This ratio was generally greater than unity with steady weather or brisk winds, but smaller south of the Equator on the way to New Zealand, when calms and light, baffling winds (doldrums) were met with. The radio-active emanations on the land thousands of miles away could not have had any effect on the ionisation; the ionisation was not increased by winds (supposed action of wind friction), nor by sunlight, nor was it greater in regions of high air pressure, so that the ionisation could not have been caused by kathode rays from the sun penetrating downward with descending air-currents. The relative humidity had no effect on the ionisation. H. B.

1998. *Perturbations of Terrestrial Electric Charge.* **A. Nodon.** (Comptes Rendus, 147. pp. 654–655, Oct. 12, 1908.)—In previous papers the author has outlined a new method of experimentally determining the variations of the earth's electrical charge [see Abstracts Nos. 2079 (1907), 655 (1908)]. On Oct. 2, 1908, important disturbances were noticed at Bordeaux; at 8 a.m. the disturbance reached the value of 150 volts per sec., and by midday they had attained to 800 volts. These phenomena appeared to concur with the passage of a region of solar activity, and with strong electric fields as observed at the Pic du Midi. It is suggested that these phenomena precede great atmospheric disturbances, and may prove useful for forecasting. C. P. B.

1999. *Electric Disturbances and Perils on Mountain-tops.* **J. E. Church, Jr.** (Science, 28. pp. 651–653, Nov. 6, 1908.)—On July 24, 1906, an observer was killed on the San Gorgonio, 9,500 ft. high, and on July 26 another on Mt. Whitney, 14,515 ft., 180 miles away, on the other side of the Mojave Desert, apparently by the same electric disturbance, accompanied by snowstorms. Referring to this case, the author relates that R. M. Brambila and himself observed lightning and extraordinarily strong brush discharges on Oct. 19, 1907, on Mt. Rose, 10,800 ft., situated north of Lake Tahoe, also in California, about 200 miles north of Mt. Whitney. No brush discharges were noticed within the Observatory hut, which is covered with Malthoid roofing. As a rule the thunderstorms are seen below the Observatory level. H. B.

DISCHARGE AND OSCILLATIONS.

2000. *Probable Cause of Auroræ.* **P. Villard.** (Comptes Rendus, 147. pp. 740–742, Oct. 26, 1908.)—A closed circuit of invariable shape but partially composed of ions is the seat of an induced e.m.f. when it is caused to rotate round the axis of a magnet. The rotation of the conducting surface of the earth with the ionised atmosphere above it forms an analogous case in which there is an e.m.f. of from 100,000 to 150,000 volts directed from the equator to each of the poles. By means of Paschen's law the height of 100 to 150 km. is found at which the pressure would be sufficiently low for a discharge to take place between two points at a distance of an earth's quadrant.

G. E. A.

2001. *Ionisation by Ultra-violet Light.* **E. Bloch.** (Comptes Rendus, 146. pp. 892–893, April 27, 1908.)—Air is ionised considerably by ultra-violet light, but the conductivity rapidly falls to a small fraction of its amount. When the air is filtered through cotton-wool there is practically no ionisation. The latter is therefore probably due to the dissociation of suspended particles.

E. E. F.

2002. *Diffusion of Gaseous Ions.* **É. Salles.** (Comptes Rendus, 147. pp. 627–629, Oct. 12, 1908.)—When an ionised gas traverses a metallic tube, the ions against the wall have their charges neutralised by the charges of opposite sign induced on the metal, so that there appears a gradient in the ionic concentration and a diffusion of the ions towards the wall. Knowing the coefficient of diffusion and also the mobility, the atomic charge can be calculated [see Townsend, Abstract No. 1108 (1901)]. From results obtained by Rutherford, J. J. Thomson ("Conduction of Electricity through Gases," p. 28) concludes that to the diffusion is added a specific effect due to the metal of which the tube is composed. The results of the author's experiments with tubes of German silver, brass, and steel do not indicate such specific effect. The values found for the positive ions seem to show that the coefficient of diffusion of these ions is intermediate to the two numbers given by Townsend (*loc. cit.*). T. H. P.

2003. *The Recombination of Gas Ions.* **G. Rümelin.** (Phys. Zeitschr. 9. pp. 657–661, Oct. 15, 1908. Physikal. Inst., Freiburg.)—A gas in the ionised condition does not suddenly lose its conductivity when the ioniser ceases its action, but gradually; the decrease of the number of ions in a $cm.^3$ after the cessation of the ionising action being due to two causes—the recombination of the positive and negative ions, and the diffusion of the ions to the surrounding surfaces, to which they give up their charge. In researches on the recombination of the ions, the chief source of error is that due to their diffusion. But the diffusion is a slow process compared with the recombination, and thus a short time after the commencement of the ionising action the concentration of the ions is not markedly changed by diffusion. In this paper an account is given of an investigation with the object of working out a method for the determination of the coefficient of recombination from the rise of the concentration of the ions. J. J. S.

2004. *Influence of Pressure on Ionisation.* **E. Rothé.** (Comptes Rendus, 147. pp. 785–788, Nov. 2, 1908.)—A study was made of the effect of change of pressure on the ionisation produced in gases by Röntgen rays. Two plates insulated and at a distance apart of 4 cm. were placed in a large brass cylinder in which the pressure was varied from 0·1 to 5 atmos. Röntgen rays were caused to pass between the plates without touching them, to avoid complications with secondary rays. One plate was kept by a battery of secondary cells at a potential of 600 to 800 volts, the other was first joined to earth, and when the permanent state was attained was insulated and its potential observed by an electrometer. The law of variation of the intensity of the saturation current as a function of the pressure was experimentally investigated independently of all hypotheses. It was found that between the limits of pressure stated the saturation current increased proportionally to the pressure.
J. J. S.

2005. *Conductivity imparted to Gases by Electric Discharge.* **H. R. v. Traubenberg.** (Phys. Zeitschr. 9. pp. 718–726, Oct. 25, 1908.)—Various gases were exposed to the action of the spark discharge or to an arc formed between electrodes of different metals and carbon, and the conductivity which they gained was observed in another vessel by means of an electroscope, both during the action of the spark or arc and after it had ceased to act. The high conductivity produced was found to last for hours after the removal of the spark or arc in the case of illuminating gas and of acetylene, but soon disappeared in the case of other gases. Illuminating gas was more particularly investigated, and the conductivity of long duration was found to depend in a high degree on the material of the electrodes and the kind of discharge. The conductivity sometimes in course of time fell away from its normal value. It increased under some circumstances from lower to higher values: in no case was there a saturation current in the gas, but the conductivity rather depended on the tension applied and increased with gradual rise of this, but too great an increase of the applied potential, or too long an application, could cause retrogression of the conductivity. When the gas before examination was caused to pass through tubes filled with wadding, or through strong electric fields, its conductivity was not at all destroyed. In the gas thus made conducting a very fine dust of peculiar structure could be seen. The conductivity had a pronounced unipolar character. It is suggested that the transport of electricity in the gas artificially rendered conducting may take place (1) by means of ions moving with difficulty and slowly recombining, which are derived from the spark or arc and afterwards exist in the gas; (2) by means of smaller or larger dust particles; (3) by means of bridges made by the coming together of such dust particles.
J. J. S.

2006. *Absorbed Gases and the Photo-electric Activity of Metals.* **V. L. Chrisler.** (Phys. Rev. 27. pp. 267–281, Oct., 1908.)—Hydrogen is the important factor in the photo-electric current; probably if the metal could be entirely freed from hydrogen it would give no photo-electric current. Relatively large values are obtained after use of the metal as kathode in hydrogen; but these are probably due to a rapid recovery of the metal after standing in the gas, and it is likely that an immediate test of the metal after use as kathode in hydrogen, if such were possible, would reveal an activity no greater than that obtained under the same circumstances in helium. By standing in the non-conducting gas, after use as kathode in hydrogen, the metal often became negatively, and after use as anode positively, charged: as if hydrogen carried a negative charge with it on being absorbed or given out. Photo-electric activity of silver or of carbon is slightly increased in nitrogen; in most cases the photo-electric activities were larger in nitrogen than in either helium or oxygen, perhaps through more intense cleaning currents (metal used as kathode) being used in the nitrogen experiments. All tests of the photo-electric current were made in the same atmosphere as that which served for the glow current. A. D.

2007. *Magnetic Rotation of Electric Discharge.* **D. N. Mallik.** (Phil. Mag. 16. pp. 531-550, Oct., 1908.)—The discharge in a De La Rive's tube, in general, passes through three stages, "showery," "band," and "glow." In air, when the distance between the electrodes is small, the first stage is absent. The discharge rotates under the influence of the magnetic field only when it is in the form of a "band," over a range of pressure depending on the nature of the gas or vapour in the tube, the e.m.f. producing the discharge, and the distance between the electrodes. In gases (group A) such as air, H, N, N_2O (*i.e.*, probably all elementary gases and those which do not decompose under the electric discharge) for a certain range of pressure (depending on the distance between the electrodes and the e.m.f. producing the discharge) $p/T =$ const., which varies inversely as the density of the gas; T being the period of rotation at pressure p. For lower pressures, in group A, p/T decreases as the pressure p decreases. In other gases (group B) such as CO_2, SO_2 (which probably tend to decompose when the discharge passes through them) and probably in all vapours (*e.g.*, CCl_4), p/T increases with pressure and with the density of the gas. In group A, within the range of pressures through which $p/T =$ const., the p.d. between the electrodes is a linear function of p. In groups A and B the p.d. between the electrodes increases with the density of the gas, and also with the pressure (except for very low pressures), with the e.m.f. producing the discharge, and with the distance between the electrodes. In air, and probably in all gases, the angular velocity of rotation is proportional to the e.m.f. producing the discharge, and increases as the spark-length decreases. If K_1 and K_2 be the velocities of + and − ions under unit electric intensity, S the electric intensity along the line of discharge, then $T^{-1} \propto K_1K_2S$; but since S and T both increase with density, K_1K_2 rapidly decreases as density increases. K_1K_2 is independent of the distance between the electrodes (except in so far as the p.d. in the discharge depends on it), but varies with the e.m.f. of the discharge. A. D.

2008. *Minimum Spark-potentials.* **J. E. Almy.** (Phil. Mag. 16. pp. 456-462, Sept., 1908. Phys. Zeitschr. 9. pp. 498-502, Aug. 1, 1908. Translation.)—Criticises the conclusions of Earhart, Kinsley, and others [Abstracts Nos. 514 (1901) and 1461 (1905)] that spark discharges may occur at abnormally low potentials. If precautions are taken that movement of the electrodes due to attraction, &c., is impossible, no very small sparking-potential can be obtained by making the sparking distance excessively small. For electrodes the author used fine Pt wires fused at the points, where they formed spheres only 0·008 cm. in diam. The gap between them was measured by the interferometer. In another series of experiments steel needles, with a radius of curvature of 0·0007 cm. at the point, were used. He then obtained no discharge with 330 volts when the gap was as small as a quarter wave-length of sodium light. At 360 volts a discharge was obtained, but it was a kind of glow discharge, enveloping the point of the needle, but not proceeding from the point. There is no indication that a further reduction of the spark-gap would make discharge any easier. It appears that Paschen's law of the proportionality of the sparking distance and the reciprocal of the gaseous pressure is also applicable to gaps shorter than those corresponding to the minimum sparking-potential. With liquid terminals the matter is complicated by dust particles. E. E. F.

2009. *Spark-resistance.* **D. Roschansky.** (Phys. Zeitschr. 9. pp. 627–635, Oct. 1, 1908. Inst. f. angew. Elektrizität, Göttingen, July, 1908.)—The author gives the results of investigations on the spark-resistance of an oscillatory discharge, the method used being essentially that employed by Simon in investigating the dynamic characteristic of the alternating-current arc by means of a Braun tube [see Abstract No. 1465 (1905)]. The results show that, in general, it is incorrect to speak of a spark-resistance. In special cases, however, especially at high frequencies, the spark may be regarded as an ordinary conductor. The transition from the characteristic of the ordinary arc to a damped sine curve takes place moderately rapidly. The ordinary methods used for the measurement of the damping action of the spark must, therefore, be viewed with mistrust, since only in special cases do they yield the results required of them. T. H. P.

2010. *Electric Spark in Magnetic Field.* **H. E. Schaeffer.** (Astrophys. Journ. 28. pp. 121–149, Sept., 1908.)—The object of the investigation was to study the effect of magnetic fields on the spark discharge at atmospheric pressure, the work being divided into three sections: (1) a study of the visible space-changes which the presence of a strong magnetic field causes in the spark; (2) a spectroscopic analysis of the different parts into which the spark is spread out under the influence of the magnetic field; (3) a study of the image of the spark given by a rapidly rotating mirror when the spark is in a magnetic field. Three types of spark discharge were studied under each of the above classes, viz.: (*a*) The spark obtained when neither capacity nor self-induction were introduced into the secondary circuit of the induction coil; (*b*) the spark obtained when a capacity of 0·0005 to 0·012 mfd. was introduced into the circuit; (*c*) the spark obtained when a capacity of 0·0005 to 0·012 mfd. and a self-induction of 0·008 henry were introduced. The deflection produced by the field is most striking when the spark is allowed to pass along the lines of force or perpendicular to them, the deflection taking the form of circles in the latter case and spirals in the former. The spirals appear to be wound about cones of revolution, having different angles of divergence, whereas the circles all lie in a plane perpendicular to the field. [See also Abstract No. 277 (1899).] C. P. B.

2011. *Short Spark Phenomena.* **H. Armagnat.** (Rev. Électrique, 10. pp. 314–315, Oct. 30, 1908.)—Puzzling phenomena are described in connection with the disruptive discharges which occur between the electrodes of a small induction coil giving a 10-mm. spark. At 10 mm. the sparks occur regularly, but as the pointed electrodes are brought closer together the sparks occur at irregular intervals, and at distances lying between 3 mm. and a very minute interval it is impossible to get sparks at all. If we connect a series of spark-gaps, with pointed electrodes, in parallel to the terminals of an induction coil or a magneto, then, when the spark-gaps are of the same length, the sparks occur indifferently at the gaps. But if one is about 10 mm. and all

the rest are only 2 or 3 mm. apart, the sparks take place only across the broad gap. For a given pair of electrodes at a certain small distance apart it is almost impossible to obtain a spark at all. If we have a short gap and a long gap close together, the spark takes place across the short gap. The reason of this is stated to be that the radiations from the pointed electrodes of the large gap destroy the excessive ionisation produced between the electrodes of the short gap, and so favour the passage of sparks. These experiments are easily repeated, provided that the source is not powerful enough to produce an arc between the points. With an ignition coil giving a 10-mm. spark the experiment is made easier by shunting the secondary with a condenser, as this prevents an arc forming. In the experiment described, the capacity shunting the coil was only 0·00025 mfd. Suppressing this capacity, it was impossible to find a position where there was absolutely no spark. The constructors of ignition coils are familiar with this phenomenon. It is probable that in the cylinders of explosion engines this phenomenon would not occur, owing to the violent movement of the gases and the high temperatures. It is possible that it may have some effect. [For a description of other short spark phenomena see W. Duddell, Abstract No. 1667 (1908).]
A. R.

2012. *Slow Electric Oscillations.* **W. König.** (Phys. Zeitschr. 9. pp. 788–789; Discussion, p. 789, Nov. 1, 1908. Paper read before the 80. Naturforscherversamml., Köln.)—An account of a method of observing slow electric oscillations, such as those described by Wiener [Abstract No. 118 (1908)], which resembles that employed by Richarz with the Braun tube. The oscillations of the potential and current are demonstrated by the movements of a fluorescent patch of light. When the electric and magnetic deflections are at right angles to each other and synchronous the fluorescent patch describes a spiral which can be easily photographed. J. J. S.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2013. *New Electro-optic Phenomenon.* **E. Bloch.** (Comptes Rendus, 146. pp. 970–971, May 11, 1908.)—A rectangular trough is provided with two opposite glass ends, and the sides are made of metallic plates several cm. apart. Between these plates a p.d. of several thousand volts is maintained. Ammonium chloride vapour is introduced into the trough. The trough is placed between two nicols whose principal sections are inclined 45° to the electric field vector, and in opposite directions to it. No light is transmitted when the field is stopped. But on establishing the field the light reappears. At the same time, the vapour appears to become denser and more visible. The effect disappears again instantly on abolishing the field. The phenomenon is probably due to the orientation of the crystalline dust in the electric field. It appears to be related to the phenomenon observed by Cotton with the smoke arising from the sublimation of indigotine. When subjected to the action of a magnetic field, it restores the light passing through two crossed nicols. There is also an analogy between the new phenomenon and the magneto-optic or electro-optic behaviour of certain heterogeneous liquids studied by Meslin and Chaudin. E. E. F.

2014. *Electric Double Layer.* **J. Billitzer.** (Zeitschr. Elektrochem. 14. pp. 624–630, Sept. 11, 1908.)—The author brings forward a modification of Helmholtz's theory of the electric double layer, according to which modification, this layer is regarded as partially dissociated, so that free charges united with ions are present in the metal as well as in the solution [see Abstract No. 148 (1904)]. For the maximum surface tension of mercury is not at the point where the absolute potential between metal and solution is zero; this potential was formerly found to have the value −0·8 volt, whilst the author has, by other methods, found the absolute zero-point to be +0·4 volt [Abstract No. 2688 (1904)]. Below −0·8 volt increase of the mercury surface causes the latter to become positively charged, whilst diminution of the surface leads to a negative charge; between −0·8 and +0·4 volt the opposite behaviour is observed. Similar results were obtained by Krouchkoll (Ann. chim. phys. [VI], 17. p. 129, 1889), who made observations on the p.d.'s arising when metallic wires are stretched. The charge of the stretched metal changes sign, in every case, at that potential at which kathodic polarisation of the metal leads to evolution of hydrogen. The author concludes that the supertension depends on the formation of a gaseous skin, which protects the metal from contact with the solution. So that what is measured is not the p.d. between metal and solution and methods of determining absolute potential based on Helmholtz's theory are inaccurate. T. H. P.

2015. *Electric Dispersion of Water.* **F. Beaulard.** (Comptes Rendus, 146. pp. 960–962, May 11, 1908.)—The previous work [Abstracts Nos. 2254 (1905) and 1188 (1907)] is modified by substituting a quartz ellipsoid full of water for the glass ellipsoid placed in an alternating electrostatic field. This gets rid of residual charges. The dielectric constants found were :—

$\lambda =$ 8,600 cm. $K =$ 8·321
2,700 cm. 8·315
1,200 cm. 2·787

The values for K indicate a slight anomalous dispersion, due to an absorption band extending from 10 to 40 cm. Other absorption bands are known to exist towards the infra-red. There was no loss by conduction, since the electrodes did not touch the water. E. E. F.

2016. *E.M.F. of Cells with Silicon.* **Miss F. G. Wick.** (Phys. Rev. 27. pp. 238–250, Oct., 1908.)—This is the fourth paper of a series on the electrical properties of the silicon produced by the Carborundum Co. [see Abstracts Nos. 275, 1478, 1670 (1908)]. The substance was used as one of the electrodes of a voltaic cell in combination with various metals and electrolytes. The e.m.f. was measured by the discharge through a galvanometer, of a mica condenser charged from the cell. The e.m.f. varied with different specimens of silicon. Thus when amalgamated zinc was used as the negative electrode, and the electrolyte was a 10 per cent. solution of H_2SO_4, the e.m.f. of the cell varied from 1·039 to 1·849 volts when different rods of silicon were used as the positive electrode. The internal resistance of such cells is large, and they show rapid polarisation and depolarisation. When potassium bichromate solution is used as the liquid the cell is almost free from polarisation. The investigation does not indicate that silicon has any great value as one electrode of a voltaic battery. In generating e.m.f. it has practically the same effect as carbon, but has the disadvantage of possessing a higher resistance. Various physical characteristics make the manipulation of silicon so difficult as to discourage attempts to use it for practical purposes. J. J. S.

2017. *Resistance of Two Strips of the same Thickness but different Breadths joined in Series.* **C. H. Lees.** (Phil. Mag. 16. pp. 784–789, Nov., 1908. Paper read before the Physical Soc., June 12, 1908.)—Suppose that we have two strips of metal of the same thickness t but different breadths and lengths. The resistance of the strip of length l and breadth b will be $\rho l/bt$, where ρ is the volume resistivity of the metal. Similarly if l' and c be the length and breadth of the other strip its resistance will be $\rho l'/ct$. If, however, we put them symmetrically in series their resistance will be greater than $\rho l/bt + \rho l'/ct$, for the lines of flow of the current will not be straight when passing from one strip to the other except when $b = c$. The author, by means of a suitable Schwarzian transformation, finds the equations to the stream lines, and deduces the exact expression for the increase in the resistance when the strips are infinitely long. He draws the stream lines and equipotential lines at the junction when the ratio of the breadths is 2/1, and compares it with the same lines found experimentally. The agreement is extremely satisfactory. The results show that even if the lengths be only 5 or 6 times the breadths, his correction may be used in certain cases even when high accuracy is required. The following table enables the increase in the resistance due to the joint to be found:—

b/c.	a.	b/c.	a.
1·0	0·0	3·0	0·48
1·2	0·032	4·0	0·65
1·4	0·080	6·0	0·90
1·7	0·17	10·0	1·24
2·0	0·25	15·0	1·46
2·5	0·37	20·0	1·65

The total resistance is $\rho l/bt + \rho l'/ct + \rho a/t$, where a is found from the table.

A. R.

2018. *Dielectric Constant of Mica.* **E. Mattenklodt.** (Ann. d. Physik, 27. 2. pp. 359–376, Oct. 15, 1908. Extract of Dissertation, Greifswald, 1908.)—The principal object of the investigation is to find whether the dielectric constant is affected (1) by the strength of the electric field; (2) by temperature. Two condensers, of nearly equal capacity, are compared with each other by the Wheatstone Bridge and alternating-current method (1) when a much stronger electric field exists in the one than in the other; (2) when one is at a higher temperature than the other. Each condenser consists of two capacities in series so that by connecting the two inside coatings to a Holtz influence machine a strong electric field may be maintained in the condenser. The "null" position is observed by means of a filament-galvanometer and a microscope. The mica plates are silvered, and not merely coated with tin-foil. The results are: (1) The dielectric constant of mica shows no appreciable change even when the electric field is raised to 600,000 volts per cm. A change of 1 in 100,000 would have been detected; therefore mica shows no dielectric hysteresis. (2) The dielectric constant shows no appreciable change with a temperature difference of 80° C. A change of 1 in 10,000 would have been detected. (3) The dielectric constant of the mica used is found to be between 7·1 and 7·7. Former observers have found values ranging from 5·7 to 8·4.

T. P. B.

2019. *Compensation Electrometers and Electroscopes.* **Hurmuzescu.** (Comptes Rendus, 147. pp. 788–791, Nov. 2, 1908.)—In order to avoid various errors involved in measuring p.d.'s by the divergence of the leaves of an electroscope, the author has made use of a method of compensation in his observations on radio-activity. Instead of measuring the variations of the angle of divergence *a*, the value of *a* is brought back to its initial amount by a variation, symmetrical and linear, of the capacity of the electroscope, by means of a micrometer screw whose head has a graduated disc. The loss of charge may be found directly, or the value in volts of the displacement of one division of the screw-head may be determined. The variation of capacity must be made in such a way that there is no modification of position between the different metallic pieces and the movable leaves of the electroscope. The model employed has given excellent results, and the instrument can be constructed for determined degrees of sensitiveness. It is easy to read to 2/100 and 1/100 of a volt. J. J. S.

ALTERNATING CURRENTS AND MAGNETISM.

2020. *Temperature Variation in Wires carrying Alternating Currents.* **H. Ebeling.** (Ann. d. Physik, 27. 2. pp. 391–435, Oct. 15, 1908. Extract of Dissertation, Göttingen.)—The paper treats of the heating of a wire by an alternating current, but especially of the temperature variation during one complete current cycle. An equation connecting the temperature at any instant with the various quantities involved is theoretically deduced. By means of this and the watts used at the instant, curves are drawn showing the connection between *e* and *i* at that instant. These curves are called dynamic characteristics. The manner of drawing them is described [see also Abstract No. 1465 (1905)]. The curves are of a hysteresis-like character, and show that, when *i* is falling, higher values of *e* correspond to it than when *i* is rising. The form of these curves is afterwards confirmed by experiment. In the experiments *e* and *i* are obtained by an oscillograph. Thus the resistance of the wire is obtained at each instant, and so the temperature at that instant is deduced from a knowledge of the temperature-coefficient of the wire. Fine Pt wires are used, but in some experiments nickel wires also. The radius of the wire and the frequency of the current are varied. Experiments are carried out in air at different pressures, in hydrogen and in coal gas, and the specific heat-emissivity of the wire and the heat-content of the atmosphere surrounding the wire are determined in each case. The results are as follows: (1) Newton's law of cooling, that the heat emitted is proportional to the surface of the wire and the excess temperature, T, does not hold. The heat emitted is inversely proportional to the radius of the wire and directly proportional to T^b, where $b =$ Dulong and Petit's constant. The experiments give 1·25 as the best value for *b*. (2) With a Pt wire in air, as the air pressure is raised above 1 atmo. *b* increases, but in spite of this the heat emitted decreases. Also as the pressure is lowered below 1 atmo. the heat emitted decreases, so that the rate of heat-emission is a maximum at a pressure of about 1 atmo. (3) *b* seems to be the same for all gases at a pressure of 1 atmo. (4) The specific heat-emissivity of the wire, and the heat-content of the gas surrounding the wire, depend on T and the radius of the wire. These two constants are determined for particular cases. (5) Finally the experiments are extended to the filaments in incandescent lamps, and it is found that the variations of temperature are very much greater in metal filaments than in carbon filaments. Perhaps this is the cause of the short life of metal-filament lamps as compared with carbon filament ones when alternating current is used. T. P. B.

2021. *Relation between the Magnetic and the Chemical Properties of Complex Ferric Salts.* **P. Pascal.** (Comptes Rendus, 147. pp. 56–58, July 6, 1908.)—The author has used the well-known U-tube method to measure the magnetic susceptibilities of a number of solutions of ferric salts containing the same weight (2·85 gm.) of iron per litre. He finds that the diamagnetism of water is not much diminished by the addition of potassium ferricyanide; it is reduced more by ammoniacal ferric pyrophosphate or sodium ferric pyrophosphate; much more, almost to the same extent, by sodium ferric metaphosphate and by ferric chloride. It will be noticed that the substances mentioned are arranged in a regular chemical (as well as magnetic) order passing from the least to the most typical ferric salt. Solutions of ferrimetaphosphates and of ferripyrophosphates exhibit magnetic double refraction. D. H. J.

2022. *Magnetic Properties of Metallic Oxide Radicals.* **P. Pascal.** (Comptes Rendus, 147. pp. 742–744, Oct. 26, 1908.)—The subject referred to in Abstract No. 1686 (1908) is again taken up for the particular case of metallic salts in which the metallic oxide radical may be kathion or anion. Examples are given in which the magnetism of the oxide anion is less than that of the metal kathion (salts of Mn, K, Cr, V). In other cases (salts of V and U) the magnetism of the metal ion is decreased progressively with each addition of oxygen whether the oxide radical is an anion or a kathion. [See also preceding Abstract.] F. R.

2023. *Magnetic Sensitiveness produced by Annealing.* **J. G. Gray** and **A. D. Ross.** (Roy. Soc. Edinburgh, Proc. 28. pp. 615–626, 1907–1908.)—A continuation of the work dealt with in Abstract No. 970 (1908). It is devoted to the properties of the "sensitive state" (*i.e.*, enhanced susceptibility produced by annealing) exhibited under various treatments, and is summarised as follows: (1) Nickel and Heusler's alloy give sensitive states of nearly 2 and about 5 per cent. respectively for a magnetising force of 8 c.g.s. units. (2) Steel wire specimens dropped vertically on to a stone slab from a height of 1 m. showed a reduction of 37 per cent. in the sensitive state for a single fall, 49 per cent. for three falls, 62 per cent. for ten falls, and 78 per cent. for fifty falls. (3) After removal of the sensitive state by reversals [*loc. cit.*] it cannot be completely restored by annealing. (4) This "fatigue" effect in one specimen of steel amounted to a reduction of the sensitive state to one-fifth after 17 sets of reversals and annealings. (5) Recovery from fatigue did not take place after a period of rest of 54 days. (6) Repeated annealings (without intervening reversals) neither increase nor decrease the sensitive state. (7) Specimens demagnetised at —190° C., heated to room temperature and cooled again to —190° C. showed a small "sensitive state" at that temperature. (8) Larger effects were induced by heating from —190° to 15° or by cooling from 15° to —190°. (9) The sensitive state could be induced by change of temperature, but not by steady temperature. (10) The amount of sensitive state for a given change of temperature varies with the position of the mean temperature on the temperature scale. (11) The change from the sensitive state to the normal state is unaccompanied by appreciable change in the electrical resistance or the elastic constants of the material. J. D. C.

2024. *Magnetic Hysteresis.* **U. Cisotti.** (Accad. Lincei, Atti, 17. pp. 418–420, April 5, and pp. 509–518, April 26, 1908.)—A general discussion of hysteresis loops on the assumptions: (1) That the curves are governed by a first-order differential equation capable of two solutions, the cycle being composed of the two integral curves; (2) that in the variation of states the effect may exert a preponderating influence upon the cause. The relation between coercive force F and residual magnetism r is given approximately by the hyperbolic equation $F = br/(a + r)$. F varies between $b/2$ and $b/8$. All the magnetic properties of bodies are defined once a and b are known. In the second paper the author specifies the best method for obtaining the constants a and b from pairs of values of F and r. For soft iron wire the values are: $a = 1{,}054$, $b = 8{\cdot}8$. For tempered steel $a = 600$ and $b = 80$. In this case the coercive force cannot be less than 10 nor more than 15, so that all types of hysteresis curves for that material are comprised within those limits. The author gives some calculated curves compared with Ewing's experimental curves. E. E. F.

2025. *Permeability of Iron at High Frequencies, using Undamped Oscillations.* **L. Schames.** (Ann. d. Physik, 27. 1. pp. 64–82, Sept. 25, 1908.)—All the previous measurements of permeability at high frequencies have been made with damped oscillations. The author employs an arc with plain 8-mm. carbons burning in air for frequencies up to 20,000 and in a Bunsen flame for the higher ranges. The permeability is calculated from the ratio of the flux of induction in a coil of wire (251 turns in 8 layers on a 10-mm. glass tube) with an iron core to the said flux when no core is in the coil. The core consisted of 100 fine, soft iron wires 15 cm. long and of total cross-section $2{\cdot}06 \times 10^{-3}$ cm.^{2}. The accuracy of the measurements is about 8 per cent. The correction to be applied to the voltage readings across the coil is very small, but that for the shielding action of the exterior of the wires is calculated to be 2·6, 5, 7, and 18 per cent. for respective frequencies of 88, 124, 154, and 220, all multiplied by 10^3. Making use of these corrections the curves for the different frequencies when H is plotted as abscissa and μ as ordinate show that while for frequencies of 2,400–8,500 at $H = 20$ the value of μ is fairly high (700–750), but descends sharply to about 850–400 at $H = 68$, at higher and higher frequencies the curve becomes nearly straight and runs almost parallel to the H-axis, μ having mean values of about 425 for frequency 62,500, 885 for 110,000, and 860 for 152,000, all at about $H = 80$. These values of μ are, it is pointed out, only effective mean values of all the values run through in the course of one period, hence the permeability can here be greater than what one is used to in measurements with direct current. As explaining this action an hypothesis is put forward according to which the permeability in a rapidly alternating field has not time to arrive at the end value which it would reach with direct or slowly alternating current magnetisation; and thus in the case of a curve falling with increase of frequency the permeability would correspond to that at a part higher up on the curve. This hypothesis explains also the results obtained by other workers, notably Varley [Abstract No. 1892 (1902)]. L. H. W.

2026. *Movement of freely suspended Magnetic Needle.* **J. de Moidrey.** (Terrestrial Magnetism, 18. pp. 129–180, Sept., 1908.)—Supposing a magnetic needle freely suspended, and an observer situated at the point of suspension and looking at the North Pole, Bauer has shown that for most stations the movement takes place in the same direction as the hands of a watch. The present paper is to show that abnormalities occur at some stations; for instance, at Manilla the rotation is anti-clockwise, but it is unfortunate that no observations were available there from 1840 to 1887. At Zi-Ka-Wei and Hong Kong, while the rotation since 1875 until recent years has been clockwise, there has been a decided tendency later for a motion in the opposite direction. C. P. B.

2027. *Cause of Magnetic Storms.* **K. Birkeland.** (Comptes Rendus, 147. pp. 539–543, Sept. 21, 1908.)—In a classification of magnetic storms the author first divides them into *elementary* and complex; the former are again subdivided into four categories, positive and negative *equatorial* storms, and positive and negative *polar* storms. In an equatorial storm the component of the disturbing force is directed perpendicular to the magnetic equator, towards the north if positive, towards the south if negative. It is almost constant round the equator, and becomes more feeble towards high latitudes. Numerous experiments were then made with a magnetic sphere enclosed in a large vacuum discharge tube, the phenomena observed showing some resemblance to what may be taking place round the earth owing to external influences. Photographs of some of the appearances are shown. It is known from the Norwegian observations that when a magnetic storm is approaching strong earth currents are produced, which gradually become zero and then change sign when the storm is at maximum. **C. Störmer.** (Ibid. pp. 733–735, Oct. 26, 1908.)—Störmer states that he has developed a mathematical analysis covering all the phenomena described by Birkeland, and the present paper has illustrations of models made to show the theoretical paths of the diverted rays. [See Abstract No. 1604 (1906).] C. P. B.

2028. *Magnetic Disturbances and Aurora Borealis.* **W. Sidgreaves.** (Nature, 78. p. 663, Oct. 29, 1908.)—Details of an unusually bright aurora seen at Omaha, U.S.A., on the night of Sept. 28, 1908, are discussed in connection with the 3-hour magnetic disturbance recorded on the Stonyhurst magnetograms between 4 a.m. and 7 a.m. Sept. 29, 1908. It appears that the auroral display began and ended synchronously with the greater deflection of the needle. C. P. B.

REFERENCES.

2029. *Moving Distributions of Electricity.* **A. W. Conway.** (Roy. Irish Acad., Proc. 27. Section A. pp. 1–8, Jan., 1907.)—A highly analytical paper dealing with moving electrons and using both the scalar potential and Maxwell's vector potential. The general result obtained is a set of equations like those of Maxwell, but with the convection current added to the displacement current. E. H. B.

2030. *Electromagnetic Theory.* **G. Fubini.** (Accad. Lincei, Atti, 17. pp. 325–330, March 15, 1908.)—A sequel to a former paper [Abstract No. 858 (1908)]. The theory developed is more in accordance with Hertzian ideas than with those theories according to which a dielectric layer in an electromagnetic field gives rise to a double-layer integral. Blondlot's objection to Crémieu's experiment, based on the metallic surfaces employed by the latter, applies also to dielectric surfaces, and it cannot be met by earthing the surfaces in question. The author gives a formula which he regards as a rigorous solution of the problem. E. E. F.

2031. *Theory of the So-called Spark-resistance.* **D. Roschansky.** (Phys. Zeitschr. 9. pp. 635–641, Oct. 1, 1908.)—[See Abstract No. 663 (1908).] T. H. P.

2032. *Faraday-effect in Gases.* **L. Natanson.** (Acad. Sci. Cracovie, Bull. 3. pp. 129–139, March, 1908.)—A simple mathematical treatment of the molecular mechanism of the magneto-rotatory power, on the basis of the Maxwell-Lorentz field equations. The author considers two opposite circularly polarised wave-systems propagated in a mono-electric medium, and specifies the conditions under which the amplitudes of the two waves are made to differ by a magnetic field parallel to the direction of propagation. E. E. F.

2033. *Convective Streaming of Electricity in Highly Ionised Gases.* **L. Heis.** (Phys. Zeitschr. 9. pp. 620–627, Oct. 1, 1908.)—A theoretical treatment following on the lines of J. J. Thomson and Riecke, the equations being worked out so as to be in the most general form. L. H. W.

2034. *Saturation Current and Current Curve.* **G. Mie.** (Ann. d. Physik, 26. 3. pp. 597–614, July 7, 1908. Physikal. Inst., Greifswald.)—A mathematical discussion of conduction in a medium poor in ions [see Abstract No. 1745 (1904)]; in the present case the poor conductor is the liquid, ethyl ether, in which a saturation current has been observed by J. Schröder, whose observations will be published shortly. L. H. W.

2035. *Sine-wave Electrical Oscillator.* **F. K. Vreeland.** (Phys. Rev. 27. pp. 286–293, Oct., 1908. Paper read before the Amer. Physical Society, Feb., 1908. Electrical World, 52. p. 1134, Nov. 21, 1908.)—A description of the mercury vapour device previously described in Abstract No. 226B (1907), with oscillograms of the current obtained therewith. L. H. W.

2036. *Induction-spark.* **A. Heydweiller.** (Ann. d. Physik, 26. 5. pp. 1019–1028, Aug. 25, 1908. Physikal. Inst., Rostock, July, 1908.)—Criticises the formula of Corbino [Abstract No. 290 (1908)], and proposes another containing four constants instead of two. None of the formulæ fit the observations exactly. E. E. F.

2037. *Measurement of Small Quantities of Electricity.* **A. Einstein.** (Phys. Zeitschr. 9. pp. 216–217, April 1, 1908.)—A sensitive quadrant electrometer is capable of measuring down to 10^{-8} volt. This sensitiveness can be surpassed by a kind of influence machine, which multiplies the original small charge until it has become measurable. The author indicates several solutions of this problem. E. E. F.

2038. *Magnetic Quality of Molecular Magnets.* **W. Peddie** (Roy. Soc. Edinburgh, Proc. 28. pp. 643–651, 1907–1908.)—In a former paper [see Abstract No. 341 (1906)] an investigation was given of the magnetic properties of the closest packed homogeneous cubic arrangement of molecular magnets, and it was found that the results were in good agreement with the observed properties of crystals of magnetite. The present paper gives an investigation of other cubic arrangements leading to a possible discrimination of molecular arrangement, so far as the magnetic constituents are concerned, in actual crystals. A. W.

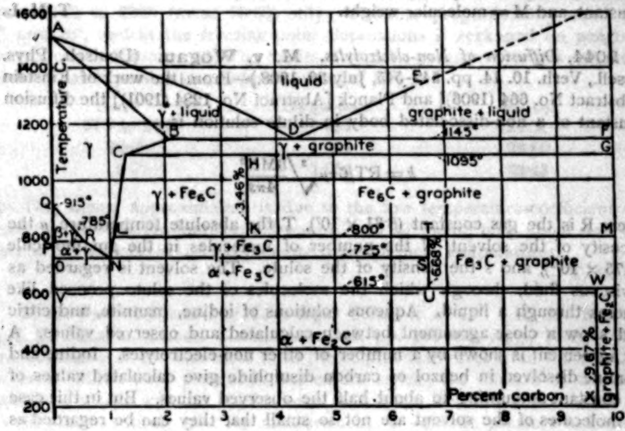
CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

2039. *New Element in Thorianite.* **M. Ogawa.** (College of Science, Imperial Univ., Tōkyō, Journ. 25. Article 15. pp. 1–11, 1908. Chem. News, 98. pp. 249–251, Nov. 20, 1908.)—Thorianite, reinite, and molybdenite contain a new element, which the author terms "*nipponium*" (Np), the properties of which he has investigated. The chloride gives a characteristic line, besides two other feebler lines, in the green-blue part of the spectrum, the wave-length being 4,882. The equivalent weight of the element is about 50, and it is probable that the element fills the gap between molybdenum and ruthenium, its atomic weight being about 100. The element appears to exist in two degrees of oxidation. T. H. P.

2040. *Action of Aluminium on Silica and Boric Anhydride.* **F. E. Weston** and **H. R. Ellis.** (Faraday Soc., Trans. 8. pp. 170–176; Discussion, pp. 177–178, March, 1908.)—The factors which affect the ease of starting the reaction between mixtures of Al and B_2O_3 or Al and SiO_2 are shown to be the fineness of division and the proportions of Al to oxide. With finest Al-powder, and B_2O_3 which had passed a sieve of 14,400 meshes per sq. in., in molecular proportions, the reaction was started in the cold with a fuse of Mg ribbon and BaO_2. With more or coarser B_2O_3 the reaction could only be started after heating the mixture. It is shown that free boron was obtained as a product, but it is difficult to separate this from Al_2O_3 and borides of aluminium. Mixtures of silica and Al-powder in the proportions $4Al + 8SiO_2$ would not commence to react in the cold, using a fuse of BaO_2 and Mg, but with the proportions $1Al + 8SiO_2$ the reaction started readily in the case of kieselguhr or precipitated SiO_2, but only on heating to redness in the case of silver sand. Silicon was obtained as a product, but it was contaminated by Al_2O_3. In the *discussion*, **R. Seligman** pointed out the possible effect on the commencement and temperature of the reaction due to the burning of part of the Al in the air; this occurs in the manufacture of Al. The fused alumina is being made into fire- and acid-resisting ware. **F. E. Weston** considered that although a slight preliminary burning of the Al in the air may have affected the commencement of the reactions, once the reactions had started the air had no further part in them. F. R.

2041. *The Binary Systems: Cu—Cu_2Se, Ag—Ag_2Se, and Pb—PbSe.* **K. Friedrich** and **A. Leroux.** (Metallurgie, 5. pp. 855–858, June 22, 1908. Communication from the Metallograph. and Metallurg. Laborat. d. Kgl. Bergakademie, Freiberg.)—*System: Cu—Cu_2Se.*—The eutectic of Cu and Cu_2Se occurs when the melt contains from 2 to 8 per cent. Se, and solidifies at about 1,068° C. Cu_2Se solidifies at about 1,118°. *System: Ag—Ag_2Se.*—These melts tend to separate into two layers, one probably consisting of a solution of Ag in Ag_2Se, solidifying at about 890°, the other, probably pure Ag_2Se, solidifying at from 884° to 850°. The melting-point of Ag is continuously lowered with successive additions of Se until the melt contains about 7 per cent. Se when the 890° line is reached. *System: Pb—PbS.*—The diagram consists of a horizontal line at 825°, corresponding to the separation of lead, and of a curve gradually rising from 825° with no Se to 1,100° when the composition corresponds to PbSe. Although it was not shown that PbSe corresponds to a maximum on the diagram, yet duration of solidification and the homogeneous structure indicate the existence of the compound. F. R.

2042. *Iron-Carbon Equilibrium.* **G. B. Upton.** (Journ. Phys. Chem. 12. pp. 507–549, Oct., 1908.)—Arguing from published data the author is led to propose for the equilibrium of the iron-carbon system the diagram which is reproduced herewith. The results of Carpenter and Keeling [see Abstract No. 1796B (1904)], indicate two inversions unknown to Roozeboom. It is shown by several methods of approach in each case that these correspond to the two compounds Fe_6C and Fe_3C respectively. The current theory of the existence of a superposed metastable and stable system is regarded as a fallacy. The introduction of the above phases, of which Fe_3C has already been recognised by Campbell and Kennedy [Abstract No. 498 (1908)], and a structure found in cast irons, which is not a true phase, enable the author to explain the phenomena of the cast irons. The structure last mentioned resembles a eutectic, but is a partially decomposed solid solution which was supersaturated through rapid cooling from the molten state. One of its constituents, the separated carbon, is temper carbon. In malleableising cast iron the process of removal of carbon is (1) near the surface both dissolved and temper carbon are oxidised, the dissolved more readily than the temper carbon; (2) diffusion of dissolved carbon outwards follows, leaving temper carbon abnormally high in the interior. The curve of ready solubility of carbon in iron should be approximately O N L C H, which is confirmed by the published data of several workers on case-hardening. The carbon goes into solution, not, as often explained, in the form of Fe_3C, but as solution in γ-iron. Fe_6C occurs later, in cooling, from the breakdown of γ-iron. The "displacing powers" used in the arguments are as follows: Equivalent total carbon = total carbon + 0·45 Si + 0·10 P + 0·05 S − 0·08 Mn, where the symbols represent the percentages of the respective elements present. F. R.



2043. *Relationship between Diffusion-constant, Internal Friction, and Electrical Conductivity.* **L. Pissarjewsky** and **E. Karp.** (Zeitschr. Phys. Chem. 63. 3. pp. 257–268, June 30, 1908.)—Although the mobilities of the ions have been shown by Jones, Walden, and others to vary inversely as the viscosity of the medium in which they move, so that $u + v = K\frac{1}{\eta}$, it is noteworthy that in several cases the presence of the ions reduces the viscosity of the liquid; this is attributed by the authors to the fact that the motion of the ions depends only on the frictional resistance of the solvent molecules through which they move, whilst the viscosity of the solution depends on the friction between all the constituents, and may well be reduced if the ions are smaller than the complex molecules of the solvent. The authors have studied the behaviour of NaOH and of NaCl in aqueous alcohol, and of NaCl and of NH_4OH in aqueous solutions of cane sugar, and of acetic acid in aqueous alcohol. They conclude that for a given electrolyte $D\eta/\alpha = K$, independently of the nature of the solvent, and that for all electrolytes in all solvents $D\eta\sqrt{M}/\alpha = K$, where D = diffusion-constant, and M = molecular weight. T. M. L.

2044. *Diffusion of Non-electrolytes.* **M. v. Wogau.** (Deutsch. Phys. Gesell., Verh. 10. 14. pp. 542–545, July 30, 1908.)—From the work of Einstein [Abstract No. 664 (1906)] and Planck [Abstract No. 1284 (1901)] the diffusion constant of a non-dissociated body in dilute solution is—

$$k = RT/6\pi\mu\sqrt[3]{\frac{3MN^2}{4\pi s}},$$

where R is the gas constant (8·31 × 10^7), T the absolute temperature, μ the viscosity of the solvent, N the number of molecules in the gm.-molecule (6·175 × 10^{23}), and *s* the density of the solute. The solvent is regarded as a viscous fluid, through which the molecules of the solute proceed like spheres through a liquid. Aqueous solutions of iodine, mannite, and citric acid show a close agreement between calculated and observed values. A fair agreement is shown by a number of other non-electrolytes. Iodine and bromine dissolved in benzol or carbon disulphide give calculated values of the constant amounting to about half the observed values. But in this case the molecules of the solvent are not so small that they can be regarded as forming a continuum in comparison with those of the solute. E. E. F.

2045. *Influence of Traces of Oxides of Nitrogen upon Condensation of Water Vapour.* **E. Pringal.** (Ann. d. Physik, 26. 4. pp. 727–750, July 28, 1908.)—Experiments were made upon the influence of traces of oxides of nitrogen on the condensation of water vapour in an expansion apparatus. Oxygen, both ordinary commercial compressed and electrolytic, was used for the preparation of ozone by passage through a Berthelot ozoniser and the effect upon the condensation of water vapour compared with that produced by ozonised air. The chief results of the experiments are: (1) Pure ozone alone does not favour the condensation of water vapour; (2) if oxygen is ozonised, and oxygen, nitrogen, or hydrogen exposed to an alternating field or electric spark, and the resulting gas increases the condensation, the phenomenon is to be ascribed to the formation of oxides of nitrogen owing to impurities in the gases employed; (3) prepared ozone appears to be in the condition suitable to oxidise nitrogen in the presence of moisture, and also to oxidise a mixture of pure nitrogen already containing oxides of nitrogen. F. J. B.

2046. *Conductivity of Ferric and Ferrous Chloride Solutions.* **W. Jufereff.** (Zeitschr. Anorg. Chem. 59. 1. pp. 82–86, July 3, 1908.)—The molecular conductivities of ferrous and ferric chlorides are very similar up to a dilution of 2 litres, but beyond this the ferrous solution increases only slightly in conductivity, whilst the ferric solution shows a large progressive increase.

T. M. L.

2047. *Osmotic Pressure of Glucose Solutions at* 10°. **H. N. Morse** and **W. W. Holland.** (Amer. Chem. Journ. 40. pp. 1–18, July, 1908.)—The methods of measuring osmotic pressure have been so far improved in recent months that the experimental error is now limited to a few hundredths of an atmo., *e.g.*, in the series of measurements now described 8 duplicate determinations differed only by 0·01 atmo. and the other two by 0·04 atmo., on pressures ranging from 2 to 2·4 atmos. The present series of measurements show (1) that at 10° the osmotic pressure of glucose is proportional to the concentration, the molecular osmotic pressure ranging in an irregular manner from 23·70 to 23·87 (mean 23·80) only; a similar proportionality exists at 0° and 20°, and in the freezing-point depressions if reckoned on weight-normal concentrations. (2) The excess of osmotic pressure over gas pressure observed at 0° persists to a reduced extent at 10°.

Temp.	O.p./gas press.	Mol. o.p.
21·7 to 26·9°	0·993	24·01
10·0°	1·031	23·80
0·0°	1·052	23·45

(3) This closer approximation is due to the low temperature-coefficient of osmotic pressure, the increase between 0° and 10° being only about half as fast as the increase in the gas pressure between these temperatures.

T. M. L.

2048. *Osmotic Pressure of Cane-sugar Solutions at* 15°. **H. N. Morse** and **B. Mears.** (Amer. Chem. Journ. 40. pp. 194–213, Aug., 1908.)—The measurements at 15°, like those at 10°, were practically free from the sources of error which were present in the earlier series; the dilution of the cell contents, which was the chief source of trouble, has now been shown to occur almost entirely *after* the measurements of osmotic pressure had been made, so that the readings when uncorrected for dilution are substantially accurate. The very accurate measurements made at 10° and 15° give a ratio of the (observed) osmotic to the (calculated) gas pressure of 1·061 and 1·064 respectively, whilst the somewhat less reliable measurements at 0° and 5° gave the ratios 1·074 and 1·065. It is therefore evident, not only that there is a definite temperature-coefficient of osmotic pressure, but also that between 5° and 15° this is in very close agreement with that which is characteristic of gases. The measurements at 20° and 25° are now being repeated under the more exact conditions now available, and a fresh series of measurements is being carried out at 30°.

T. M. L.

2049. *Effect of one Salt on Hydrating Power of another Salt present in Solution.* **H. C. Jones** and **C. M. Stine.** (Amer. Chem. Journ. 39. pp. 313–402, March, 1908.)—It is shown: (1) That the complexity of the hydrates formed by a salt is a function of the amount of water present as solvent. (2) That when two salts are present in the same solution, the complexity of the hydrates is less than in separate solutions of the salts, each salt tending to dehydrate the other. (3) That the ions and the molecules of salts probably have different hydrating power. (4) That the hydrating power of the molecules is in some cases greater than that of the ions into which these molecules dissociate. (5) Additional evidence is furnished that the conductivity of a solution is not an accurate measure of its ionisation. (6) The diminution of conductivity on mixing, say, potassium and ammonium chlorides, may be due, not only to decreased ionisation, but to a change in the viscosity of the solvent or a change in the size of the ionic sphere by variations in its hydration. T. M. L.

2050. *Explosive Crystallisation.* **F. E. Weston.** (Chem. News, 98. p. 27, July 17, 1908.)—On attempting to crystallise a solution under a bell-jar in a partial vacuum, it was found that at a certain point the vessel containing the solution bumped and ejected part of the contents. The author attributes this to the sudden formation of crystals on the sides of the basin, with a consequent sudden increase in the vapour pressure of the surrounding liquid, which, under the low pressure, boiled violently. Other experiments are in progress. A. F.

2051. *"Negative" Viscosity of Aqueous Solutions.* **W. W. Taylor** and **T. W. Moore.** (Roy. Soc. Edinburgh, Proc. 28. pp. 461–471, 1907–1908.)—"Negative" viscosity was attributed by Euler to electrostriction, but this view was rendered untenable by the discovery of similar phenomena amongst non-electrolytes, *e.g.*, cyanobenzene in alcohol. Getman, following Arrhenius, has attributed the effect to the kathion, and Jones and Veazey have suggested that a large atomic volume is the chief characteristic of kathions which produce this effect. It is, however, noteworthy that, although potassium bromide shows a greater negative viscosity than the chloride, in agreement with the greater atomic volume of the bromine, the iodide with an atomic volume no greater than the bromide exhibits a still greater effect in diminishing the viscosity. The fact that potassium ferricyanide solutions give solutions of less viscosity than potassium ferrocyanide (which differs chiefly in the presence of an additional potassium atom or ion) is also difficult to reconcile with this theory of negative viscosity. The author does not advance any new theory, but describes experiments on the tetra-alkyl ammonium salts of the halogen acids, which show (1) that the influence of the anion, Cl, Br, or I, is remarkably small, but (2) that there is a great *increase* of viscosity on passing from the methyl to the ethyl and propyl salts, the behaviour of these compound radicals being opposite to that of the simple radicals of the alkali metals. Attention is directed to the peculiar densities of the tetrapropylammonium chloride solutions, which are less than those of water and decrease as the concentration increases; the tetraethyl salt shows an insignificant increase of density when the concentration is increased. T. M. L.

2052. *Spontaneous Crystallisation of Sodium Sulphate Solutions.* **H. Hartley, B. M. Jones** and **G. A. Hutchinson.** (Chem. Soc., Journ. 93. pp. 825–838, April, 1908.)—Coppet has found that the time required for crystallisation of sodium sulphate solutions varied in a regular way with the degree of supersaturation, a solution saturated at 17·4° crystallising in 1·7 days at 5·5°, but in 27·5 days at 9·5°; unlike Miers and Miss Isaac [Abstracts Nos. 1459 (1906), 1721 (1907)] he did not detect any sudden change in the properties of the supersaturated solutions when cooled. The authors have now established (1) that there is a definite temperature at which solutions of sodium sulphate crystallise when freed from nuclei and subjected to mechanical friction; (2) that a supersolubility curve may be traced not only for the crystallisation of ice from dilute solutions and of $Na_2SO_4 . 7H_2O$ from strong solutions, but also for the crystallisation of Na_2SO_4 (anhydrous), which results when the temperature of the solution is raised; (3) that the decahydrate $Na_2SO_4 . 10H_2O$ very rarely separates by spontaneous crystallisation of a supersaturated solution, and then in an erratic manner which bears no definite relation to the temperature and concentration of the solution. The determination of a supersolubility curve for a salt which decreases in solubility with rise of temperature forms a noteworthy extension of the observations of Miers and Miss Isaac. [See next Abstract.] T. M. L.

2053. *Spontaneous Crystallisation of Mixed Solutions determined by their Refraction. Mixtures of Solutions of Sodium Nitrate and Lead Nitrate.* **Miss F. Isaac.** (Chem. Soc., Journ. 93. pp. 384–411, March, 1908.)—The existence of a definite "supersolubility curve," representing the temperatures at which crystallisation takes place spontaneously in solutions of different compositions, has already been established in the case of certain simple salts, such as sodium nitrate [see Abstract No. 1459 (1906)]. An account is now given of experiments with solutions containing two salts—sodium nitrate and lead nitrate; in one series of experiments the sodium nitrate was in excess and in the other the lead nitrate. It was found that in each case a definite supersolubility curve could be traced, just as in the case of the simpler solutions previously studied, and that the phenomena of crystallisation were in all respects precisely similar. [See also Abstract No. 1721 (1907).] T. M. L.

2054. *Non-electrolytic Solution of Mercury in Water and other Liquids.* **A. Christoff.** (Zeitschr. Phys. Chem. 63. 3. pp. 346–354, June 30, 1908.)—The author finds that mercury can dissolve non-electrolytically in, and diffuse through, water containing air, nitrogen, carbon dioxide, sulphuric acid or potassium hydroxide, and also in benzene, nitrobenzene or alcohol. Reduction of a gold chloride solution in a separate vessel was taken as proof of the diffusion of mercury covered with the liquid. Further, when mercury is left for a long time in contact with water, it diminishes slightly in weight, although no mercury compounds can be detected in the liquid. T. H. P.

2055. *Lower Critical Solution Temperature of Two Liquids.* **W. Dolgolenko.** (Zeitschr. Phys. Chem. 62. 4. pp. 499–511, April 10, 1908.)—The author holds the view that liquid mixtures which form two layers on warming and become miscible again on cooling are not binary but ternary mixtures, the lower critical solution temperature being frequently caused by an unsuspected impurity in a supposed binary mixture. The case chosen for investigation was that of butyl alcohol and water, which show an upper critical solution temperature at about 110° and a lower critical solution temperature at about 10°, the two liquids being entirely miscible outside these limits. On fractional distillation of the alcohol the first fraction showed a lower critical solution temperature as usual, but this disappeared in the fractions of higher boiling-point and higher density, and was probably due to an impurity. By chemical tests the presence of *tertiary* butyl alcohol was demonstrated in the secondary alcohol that had been used, and a specimen of the latter prepared by a novel method, which excluded the formation of the tertiary alcohol, behaved like the purified material and gave no lower critical solution tem-

perature. Bruni has recently shown that a mixture of methylethylketone and water can be made to give a lower critical solution temperature by the addition of 1·5 per cent. of ethyl alcohol, thus lending important confirmation to the author's view that the phenomenon is characteristic of ternary mixtures only.
T. M. L.

2056. *Physico-chemical Properties of Mixtures of Pyridine and Water.* **H. Hartley, N. G. Thomas,** and **M. P. Applebey.** (Chem. Soc., Journ. 93. pp. 538–560, March, 1908.)—A redetermination of the density-concentration and viscosity-concentration curves for mixtures of pyridine and water at 0° and 25·08° showed in each case a max. deviation from a linear relationship at 30 molecular percentages of pyridine, but in neither case could any evidence be obtained of the discontinuities detected by the use of a bent lath by Dunstan, Thole, and Hunt. The molecular conductivity of lithium nitrate in pyridine-water mixtures at 0° and 25° was determined from $v=8$ to $v=1024$, and the values at infinite dilution were calculated by extrapolation. By means of Stokes' Law the variations of ionic size were deduced from the mobilities and the viscosities of the solutions, and it was shown that the variations of molecular conductivity could be explained as the result of variations in the coefficient of ionisation, the fluidity of the solution, and the aggregation of solvent molecules round the ions. T. M. L.

2057. *Equation of State of a Substance in the Neighbourhood of the Critical Point Liquid–Gas.* I. *The Disturbance-function in the Neighbourhood of the Critical State.* II. *Opalescence in the Neighbourhood of the Critical State.* **H. Kamerlingh Onnes** and **W. H. Keesom.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 603–610, and 611–623, March 27, 1908. Communications Nos. 104 (*a*), 104 (*b*) from the Phys. Lab., Leiden.)—(1) In a number of cases the equations of state for gases appear to be subject to some disturbing factor in the neighbourhood of the critical point; this is notably the case with methyl chloride and CO_2; Young's observations with pentane and isopentane do not show these differences. The deviations are in the direction of increased density near the critical point, and might be due to condensation of the gas around electrically charged molecules or some similar cause. (2) Spectrophotometric observations are described in reference to the blue mist which often appears in the neighbourhood of the critical point [compare Travers and Usher, Abstract No. 83 (1907)].
T. M. L.

2058. *Influence of Concentration on the Temperature of Maximum Conductivity of Feeble Electrolytes with Negative Heat of Dissociation.* **H. Wegelius.** (Zeitschr. Elektrochem. 14. pp. 514–518, Aug. 21, 1908.)—The temperatures of maximum conductivity are as follows:—

H_3PO_3	5·75	1·25	0·995	0·328	0·12	0·0472	0·0001N
	73°	54°	52°	70°	88°	above 93°	
H_3PO_4	54·3	2·715	1·955	0·217	0·0108	0·00217N	
	above 93°	77°	70°	79°	above 93°.		

T. M. L.

2059. *Vapour Pressure of Aqueous Solutions of Ammonia.* **H. Mollier.** (Zeitschr. Vereines Deutsch. Ing. 52. pp. 1315–1320, Aug. 15, 1908. Communication from the Laborat. f. techn. Physik d. Kgl. techn. Hochschule, München.)—The vapour pressures of water solutions of ammonia were determined over a range of concentrations and up to a temperature of 120° C. The water solution of ammonia was heated in a thermostat up to the desired temperature and the pressure measured in an open mercury manometer. The percentage of ammonia was determined, after the experiment, by titration with standard sulphuric acid. The results obtained, when plotted, give extremely regular curves, even up to a concentration of 50 per cent. When the results are calculated from the Lorenz-Dühring vapour-pressure formula $\theta/T = \text{const.}$, where θ is the abs. temperature of the liquid ammonia at pressure p, and T the abs. temperature of a saturated solution of concentration x, at the same pressure, a good constant is obtained. F. J. B.

2060. *Thermodynamics of Cells with Molten Electrolytes.* **R. Lorenz** and **M. G. Fox.** (Zeitschr. Phys. Chem. 63. 1. pp. 121–125, June 9, 1908.)—On applying the Gibbs-Helmholtz formula to the cells described in Abstract No. 1885 (1908), the values of the heat of formation at constant pressure of the respective salts are calculated to be: $PbCl_2$, 82·4; $PbBr_2$, 71·5; $CdCl_2$, 86·8; $CdBr_2$, 77·8; mixture of $PbCl_2$ and KCl, 88·2 cals. The agreement with the results obtained thermochemically, as far as comparison is possible, is fairly good. T. S. P.

2061. *Decomposition of Water Vapour by Electric Sparks.* **A. Holt, Jr.,** and **E. Hopkinson.** (Phil. Mag. 16. pp. 92–110, July, 1908.)—According to Perrot, 1861, the decomposition of water vapour takes place, quantitatively as in the electrolysis of liquids, along the entire spark-length, and the gas collected from the neighbourhood of the anode contains an excess of oxygen, and the kathode gas an excess of hydrogen. J. J. Thomson found that a very short spark or arc would yield an excess of hydrogen at the anode, and a long spark an excess of hydrogen at the kathode. The introduction of Leyden jars increased the critical spark-length, but the hydrogen always appeared at the anode; the charged H and O molecules were supposed to move towards opposite poles, and thus to become separated and their charges to change with the spark-length. Chapman and Lidbury observed in 1902 that the position of the point of entrance of the steam with regard to the poles is of influence. The authors consider that the separation of the two gases is essentially a diffusion phenomenon. Hydrogen diffuses at a more rapid rate through steam than oxygen, and is less influenced by the velocity and direction of the stream of vapour. Their apparatus consists of three bulbs connected by tubes, the anode and kathode bulbs being arranged symmetrically with regard to the vapour bulb below. With rapid streams nearly pure hydrogen was obtained, while in experiments with CO_2 decomposed by the sparks into CO and O—two gases which diffuse at nearly the same rates—no separation could be effected. The experiments did not explain, however, J. J. Thomson's observations, nor the fact noticed by Chapman and Lidbury that the total amount of water vapour and the separation were far greater when the vapour entered near the kathode. The authors demonstrate how catalytic recombination comes in. The electrodes are disintegrated by the discharge, especially the kathode; the metallic film deposited on the glass walls will act as a catalyser, and the amount of recombination should depend upon circumstances. The experiments are made in glass vessels, consisting of an upper and a lower bulb, both 1 cm. or 5 cm. in diam., connected by a vertical tube, the wire electrodes being mounted perpendicularly in the same. The vessels are evacuated and filled with steam, which enters below at the side; the discharge is passed for 10 min., and the gases are then withdrawn into a condenser and pump. When the lower electrode is the kathode the chief volatilisation will take place there, and the steam passing upward will not recombine in the anode vessel; when the upper electrode is the kathode there will be recombination, especially with thin electrodes and in narrow bulbs. Of the large number of metals tried, Fe, Ni, Cd, Zn, Ta, Mg, behave like Al, which covers itself with a film of oxide and is not disintegrated; there is, hence, no recombination. The other metals tried do not oxidise in air at moderate temperature; this group comprises Pt, the platinum metals, and also Os, which gives a volatile oxide; Ag and Au also rank with the latter group, Ag because it does not appear to combine with oxygen and hydrogen though it sprays rapidly. Palladium, a very powerful catalyser, behaved somewhat abnormally, but the behaviour was accounted for. As regards Thomson's observation, the authors suggest that a zone of recombination is formed around the kathode; the spark would produce a homogeneous mixture of H and O inside that zone, but H might be expected outside it, while the O would remain inside. With a very small spark-gap almost the whole production of electrolytic gas would occur in that zone; with a long spark the greater portion of the electrolytic gas would be generated outside the zone. The hypothesis of electrolysis in liquids is not applicable to the decomposition of gases by sparks; this is the final conclusion. H. B.

2062. *Speed of HCl Ions.* **E. Doumer.** (Comptes Rendus, 146. pp. 894–896, April 27, 1908.)—A direct measurement of the impoverishing of the electrolyte at both poles shows that it is sensibly the same at both. This means that in the electrolysis of HCl solutions the ionisation of the water plays a prominent part, and that the speed of the ions H and Cl is sensibly the same. [See Abstract No. 1011 (1908).] E. E. F.

2063. *Transport-Number of Dilute Hydrochloric Acid.* **K. Drucker** and **B. Kršnjavi.** (Zeitschr. Phys. Chem. 62. 6. pp. 731–742, June 2, 1908.)—The transport-number for hydrogen in HCl at 18° C. was found to be: from anode measurements, 0·1697; from kathode measurements, 0·1647. If the mobilities be taken as Cl = 65·2, HCl = 378·1, the number 0·1725 would be taken for the transport-number of chlorine; this value does not differ very much from the anode value above, but on reversing the calculation the latter would give the improbable mobility values Cl = 64·3, H = 313·8. Noyes and Kato have explained a similar discrepancy by supposing that the mobility of hydrogen at N/30 is 4 per cent. different from the limiting value at infinite dilution, but the authors are not convinced of the accuracy of this conclusion, as the figures given by Noyes do not yield a regular curve; they consider it proved, however, that the transport-number in very dilute solutions must be taken as at least 0·170, but that the mobility of hydrogen cannot exceed 313. T. M. L.

2064. *Passivity of Platinum.* **R. Ruer.** (Zeitschr. Elektrochem. 14. pp. 309–314, June 5, and pp. 633–634, Sept. 18, 1908. Commnnication from the Inst. f. physikal. Chemie d. Univ., Göttingen.)—The author describes a number of experiments which support his view that the passivity of Pt in sulphuric acid is caused by the formation of a good conducting layer of oxide rich in oxygen [see Abstract No. 214 (1904)]. When a Pt anode is electrolysed for some hours with a high current density in moderately concentrated sulphuric acid (2·5–10 per cent.), it becomes coated with a bright yellow or brownish-yellow layer, which dissolves in sulphuric acid only in presence of reducing agents such as ferrous sulphate or sulphurous acid, the solutions thus obtained containing appreciable quantities of Pt. Since this coating is formed when quartz vessels and pure reagents are employed, it can only consist of an oxygen compound of Pt. The current remains constant during the formation of the coating, so that the latter has no appreciable resistance, and the potential of the coating is the same as that of a Pt electrode saturated with oxygen. The coating has, therefore, the properties of a hypothetical peroxide [see also Marie, Abstract No. 1481 (1907)]. In the second article the author gives the results of experiments confirming his theory of the oxidisability of Pt. Electrolysis, by means of Pt electrodes, of 6 per cent. sulphuric acid and subsequently of 50 per cent. sulphuric acid, results in an appreciable loss in weight of the anode. This loss is due to the oxide formed in the dilute acid dissolving in the stronger acid, the result of which is an increase in weight of the kathode. The oxide formed on the anode in the dilute sulphuric acid is yellow, and on heating is transformed into a dark-brown and afterwards into a bluish-black substance, probably platinous oxide; on further heating, the latter disappears. T. H. P.

2065. *Passive State of Metals.* **H. G. Byers.** (Amer. Chem. Soc., Journ. 30. pp. 1718–1742, Nov., 1908.)—A summary of previous work on the passive state is first given, and then an account of the author's own experiments on Fe, Co, and Ni, in all of which the metal investigated formed the anode of an electrolytic circuit. The experiments were quantitative in nature, the loss in weight of the anode being determined in each case. The conclusions arrived at are as follows: If the metals Fe, Co, and Ni are really passive under anodic conditions, *i.e.*, show an unchanged surface, high potential-fall in the cell, and liberation of oxygen, they fail to dissolve to any extent. When a visible change in the anode surface takes place there is usually quantitative or partial anodic solution. In case the surface is covered by a visible deposit passive conditions are not a necessary consequence, but in certain cases solution of the metal may still continue. None of these three metals can be rendered passive in the halogen acids or their salts. In the oxygen electrolytes passivity may or may not occur; it depends on the current density, the temperature, and the treatment of the metal, as well as upon the electrolyte itself. The metals may be either passive or active under exactly the same current conditions, so long as the current density is below a critical value. The current density required to produce passivity varies within wide limits, and in a given electrolyte time will, to a certain extent, replace current strength. Many conflicting and perplexing results are obtained, *e.g.*, the behaviour of all three metals in acetate solutions is the same, yet it cannot with certainty be ascribed to a protecting layer of insoluble material. The experiments fail to show whether iron is passive in KCN or is simply isolated from it by a conducting layer of cyanide. Many of the results are difficult to reconcile with Fredenhagen's explanation of the nature of passivity, and no evidence is produced in favour of the valence hypothesis of Finkelstein and Müller. From a full study of the literature, and in the light of his own experiments, the author concludes that: The Faraday view of passivity is untenable. The valency hypotheses of Finkelstein and Müller are not yet demonstrated to be true or false, but in their present forms are unsatisfactory. The hypothesis of Fredenhagen, so far as it relates to anodic oxygen or an oxygen alloy as the immediate cause of passivity, is not to be reconciled with facts. At present there is no explanation of passivity which is even approximately satisfactory, but the author confidently expects that the cause of passivity will be found to be in an altered state of the metal itself, this alteration being produced by any one of a number of different agencies. [See Abstract No. 1760 (1907).] T. S. P.

2066. *Deflocculation of Colloidal Solutions in Galvanic Cells.* **W. Biltz.** (Zeitschr. Elektrochem. 14. pp. 567–571, Sept. 4, 1908. Chem. Laborat. d. Bergakademie Clausthal.)—Dipping into a small beaker containing a colloidal solution were immersed two strips of different metals, the projecting ends of which were soldered together, thus forming a galvanic cell. In most cases deflocculation of the colloid commenced after a few hours, and was almost complete after 24 hours. The pairs of metals tried were: Zn/Ag, Zn/Cu, Zn/Sn, Zn/Pb, Zn/Fe, Cu/Pb, Cu/Sn, and the colloidal solutions were the hydrosols of ferric hydrate, gold, and antimony sulphide. The gel from the ferric hydrate hydrosol, in which the particles are positive, collected chiefly round the positive pole of the cell, whereas that from the gold and antimony sulphide hydrosols, in which the particles are negative, formed chiefly at the negative pole. The deflocculation is probably due to the superposition of several causes, viz., cataphoresis brought about by the electric current; adsorption by the oxide formed when the less noble metal dissolves (the gel from the gold solution was purple and contained Zn when one of the metals forming the element was Zn); possibly deflocculation by electrolyte present. When the metals were immersed singly in the solutions there was very little, in most cases no action. Similar results were obtained with colloidal solutions formed from milk and egg-albumen. T. S. P.

REFERENCES.

2067. *Calorimetric Methods applied to the Study of Slow Reactions.* **J. Duclaux.** (Journ. de Physique, 7. pp. 747–769, Oct., 1908.)—The author describes a calorimeter suitable for measuring the heat evolved in slow reactions; he has applied the method to the study of the catalysis of H_2O_2 by ferric hydrate, and of other reactions. F. J. B.

2068. *Solubility of Silver Chloride in Mercuric Nitrate Solution.* **B. H. Buttle** and **J. T. Hewitt.** (Chem. Soc., Journ. 93. pp. 1405–1416, July, 1908.)—The work, though carried out quite independently, is very similar to that of Morse [Abstract No. 517 (1908)], whose results are in the main confirmed, though a slightly higher value is obtained for the dissociation-constant of mercuric chloride. T. M. L.

2069. *The Condition of Water Vapour.* **E. Bose.** (Zeitschr. Elektrochem. 14. pp. 269–271, May 15, 1908.)—The laws of dissociation equilibrium are applied to the anomalies observed in the density of water vapour. From the results of Kornatz (Inaug. Dissertation, Königsberg, 1908), and assuming that in water vapour the equilibrium $(H_2O)_2 \rightleftarrows 2H_2O$ exists, the density of water vapour is calculated; the values show an excellent agreement with the measurements of Kornatz. F. J. B.

2070. *Electrolytic Decomposition of Dicarboxylic Organic Acids. Pimelic Acid.* **B. L. Vanzetti.** (Accad. Lincei, Atti, 17. pp. 331–333, Oct. 4, 1908.)—Electrolysis of pimelic acid yields ethylene and propylene, together with an alcohol and an acid, but no pentamethylene. The theory of the decomposition is discussed. W. H. St.